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DENTAL DISEASE IN ITS RELATION TO GENERAL MEDICINE.

BY

SIR J. F. COLYER, K.B.E., F.R.C.S., L.D.S.,

AND

STANLEY COLYER, M.D.

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DENTAL SURGERY AND PATHOLOGY

BY

J. F. COLYER, K.B.E., F.R.C.S., L.D.S.

CONSULTING DENTAL SURGEON TO CHARING CROSS HOSPITAL
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PREFACE

When the last edition of this work was published one critic expressed the view that the usefulness of the book might be increased without adding to its bulk if less space were given to the description of operative procedures and more space were allotted to pathology. I have considered this suggestion worthy of adoption, and in the present edition have extended the sections which deal with the pathology of abnormalities in position of the teeth and diseases of the periodontal membrane and have omitted the description of the technical details of the insertion of fillings.

For figures and blocks I am indebted to:—

The Council of the Royal Society of Medicine; the Proprietors of the *Lancet;* the British Medical Association; the National Dental Association; the American Medical Association; the Publishing Committee of the *British Dental Journal;* the Medical Committee of the Royal Dental Hospital; Messrs. Claudius Ash, Sons and Co.; the Dental Manufacturing Co.; the Canadian Dental Research Foundation; Messrs. S. S. White and Co.; Mr. Henry Kimpton; Messrs. Edward Arnold and Co.; Messrs. H. K. Lewis and Co., Ltd.; Messrs. J. and A. Churchill; Messrs. P. Blakiston's Son and Co.; Messrs. Baillière, Tindall and Cox; Messrs. J. B. Lippincott Company; Messrs. Hodder and Stoughton, Ltd.; Messrs. Cassell and Co., Ltd.; Messrs. Mayer and Phelps; Mr. John Murray.

I have to thank many friends for much valuable assistance: Mr. F. St. J. Steadman for the chapter on "Local Anæsthesia in Dental Surgery"; Dr. Stanley Colyer for the chapter on "Radiographic Changes in Chronic Infection of the Jaws"; Mr. J. Howard Mummery for so kindly reading through and criticizing the chapter on "Caries"; Dr. G. F. Still for revising the part dealing with Pathological Dentition; Mr. Harold Chapman for contributing a section on "Fixed Appliances for Regulating Teeth"; Dr.

Strickland Goodall for notes on the relation of Dental Sepsis to Cardio-vascular Diseases; and Dr. Malcolm Hepburn for revising the section dealing with "Dental Sepsis and Diseases of the Eyes."

I wish to tender my thanks to Miss E. M. Wood, my secretary, for her great assistance in preparing the book for press; to Messrs. Henry and Alfred Bale, who by their careful preparation of the proof sheets have lightened my labours; and lastly, I desire to acknowledge the generous treatment I have always received at the hands of Messrs. Longmans, Green and Co., the publishers of this work.

J. F. Colyer.

March, 1923.

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DENTAL SURGERY AND PATHOLOGY

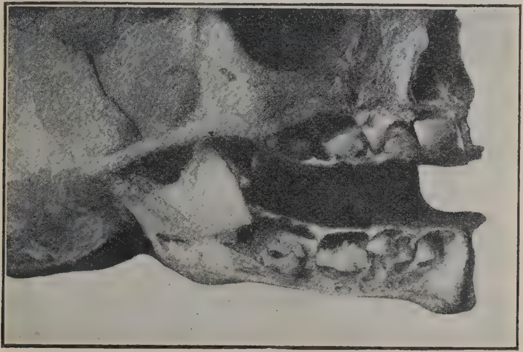
CHAPTER I

Normal Dentition

The Anatomy of Dentition—The Process of Eruption—The Eruption of the Deciduous Teeth—The Absorption of the Deciduous Teeth—The Eruption of the Permanent Teeth

(A) THE ANATOMY OF DENTITION

In the human subject the earliest manifestations of teeth are the enamel organs for the deciduous teeth, which appear during the seventh week of fœtal life, and are followed during the ninth week by the dentine bulbs. At the twentieth week calcification commences with the first and second incisors, and at the twenty-fourth week the canines and molars begin to show signs of calcification.



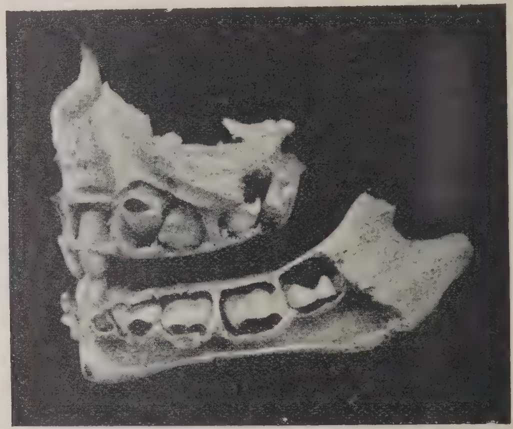
Birth.

Fig. 1.

At birth calcification of these teeth has advanced to the stage shown in fig. 1, and has also commenced in one of the anterior cusps of the mandibular first permanent molar.

At eight months the growth of the deciduous incisors and canines has progressed to the stages shown in fig. 2; the roots of the first molar are commencing to form; the crown of the second molar is almost complete, while in the permanent teeth calcification has commenced in the incisors and the canines and is well advanced in the cusps of the first molars.

At twelve months (fig. 3) the root of the deciduous canine has commenced to form; growth in the first deciduous molar has progressed beyond the division of the roots and in the second molar almost up to the division; the deciduous incisors are fully erupted and eruption of the first molars has commenced, while in the permanent teeth about half of the crown of the first molar, the upper third of the crown of the first incisor, about one-fifth of the second incisor, and the tip of the canine are formed.



Eight months.

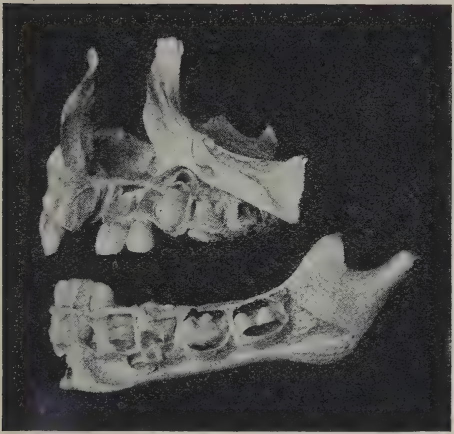
FIG. 2.

Fig. 4 shows the jaws of a child aged *fourteen months*. The first molars are in place and the canines are partially erupted.

At eighteen months the roots of the first and second incisors of the deciduous set are almost complete; about two-thirds of the roots of the canines, practically the whole of the roots of the first molars, and about half the roots of the second molars are calcified. At this period the calcification of the permanent series is as follows:—

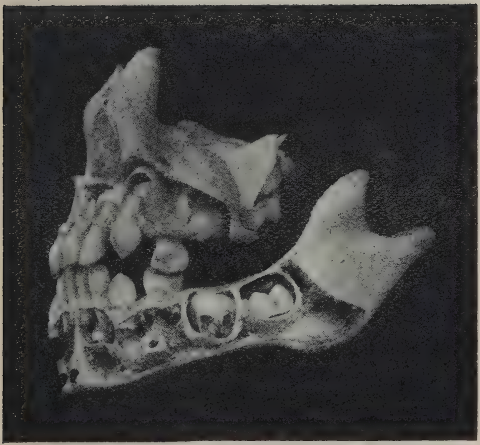
The first incisors about three-fourths of the crown.

The second incisors (maxillary) about one-fourth of the crown.



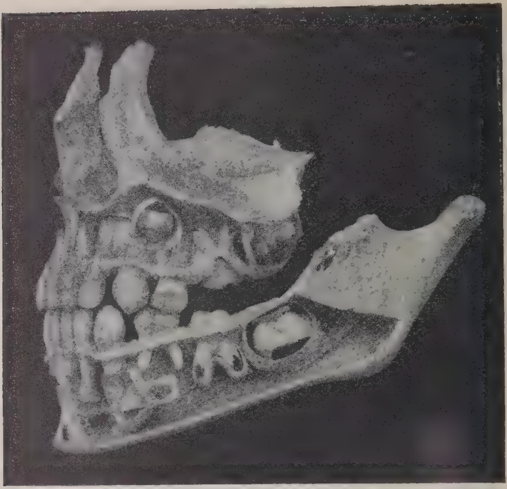
Twelve months.

FIG. 3.



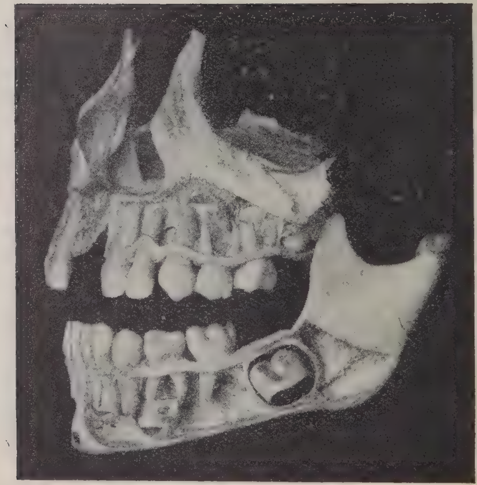
Fourteen months.

FIG. 4.



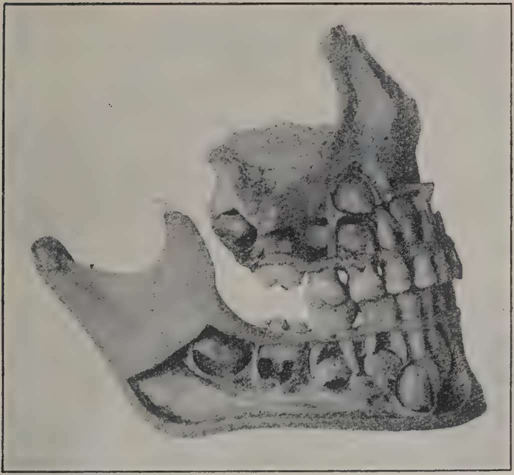
Two years.

FIG. 5.



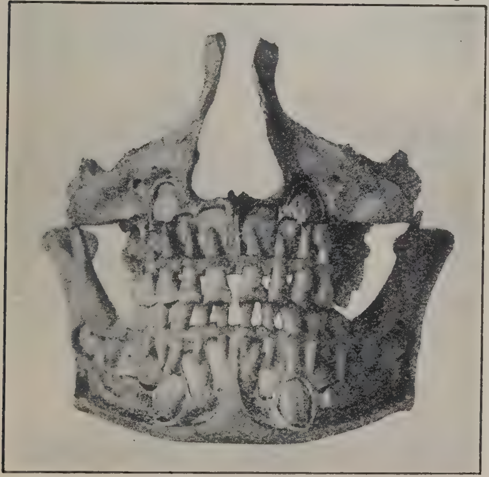
Three years.

FIG. 6.



Six years.

FIG. 7.



Six years.

FIG. 8.

The second incisors (mandibular) two-thirds of the crown.

The canines about one-half of the crown.

The first molars a little over three-fourths of the crown.

At two years (fig. 5) the formation of the deciduous teeth is complete, with the exception of the terminal portions of the canines and second molars. In the permanent series the crown of the first molar is fully formed and calcification has advanced in the incisors and canines, but their crowns are not complete.

At three years (fig. 6) the deciduous dentition is complete and fully erupted. Of the permanent teeth, the crowns of the first molars, the incisors and canines are fully formed and calcification has commenced in the mandibular first premolar, and is beginning in the corresponding maxillary tooth.

At four years calcification has commenced in the second premolars and in the second permanent molars.

At six years the permanent dentition is in the state shown in figs. 7 and 8. The crowns of the premolars are not yet fully formed, but the calcification is nearer completion in the first premolar than in the second; the roots of the first permanent molars are also partially formed; the roots of the incisors have commenced to form; the crown of the canine is barely complete; the roots of the deciduous incisors show signs of absorption on the posterior aspects.

Attention is drawn to the position of the permanent teeth in relation to the deciduous teeth. In the maxilla, the permanent first and second incisors lie behind the corresponding deciduous teeth. The permanent teeth incline outwards to a greater degree than the deciduous teeth, and consequently the permanent teeth when erupted form a larger circle. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second a little more than the first. The canine above and external to the arch of the incisors and premolars is directed slightly outwards. The second incisor lies close to the premolar, and the first permanent molar, which is in process of eruption, has the occluding surface directed outwards and backwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone with the occluding surface directed downwards, outwards and well backwards.

In the mandible the second incisors are in a plane posterior to the first incisors, and the canines are placed near the lower border of the bone and lie in a plane anterior to the second incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards. The first permanent molars are directed upwards and forwards, and the second molar is under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

Fig. 9 shows the normal occlusion of the deciduous molars. The mandibular first molar is covered in its posterior two-thirds by the corresponding maxillary tooth and the mandibular second molar is covered in its anterior third by the maxillary first molar and in its posterior two-thirds by the maxillary second molar. The posterior borders of the second molars are not flush, the bulb on the upper tooth projecting beyond the lower. It is this bulb which limits the forward movement of the maxillary first permanent molar and brings about correct occlusion.

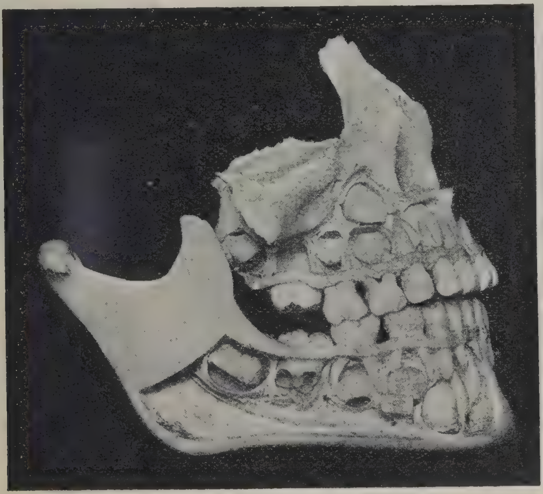


FIG. 9.

In the specimen shown in fig. 10, a child aged about *seven years*, the first permanent molars have erupted into correct occlusion. In this specimen the mandibular first incisors are partially erupted.

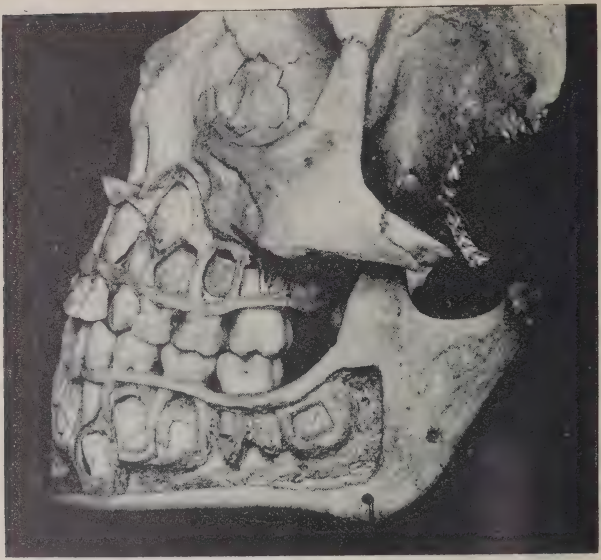
In the skull of a child *nine years* of age (fig. 11) the four first incisors, maxillary and mandibular, are in place and the roots are nearly completed. In the remaining teeth the condition is as shown below:—

Canine. About half of the root is formed. The mandibular canine is a little less advanced than the maxillary.

First premolars. About one-quarter of the root is formed.

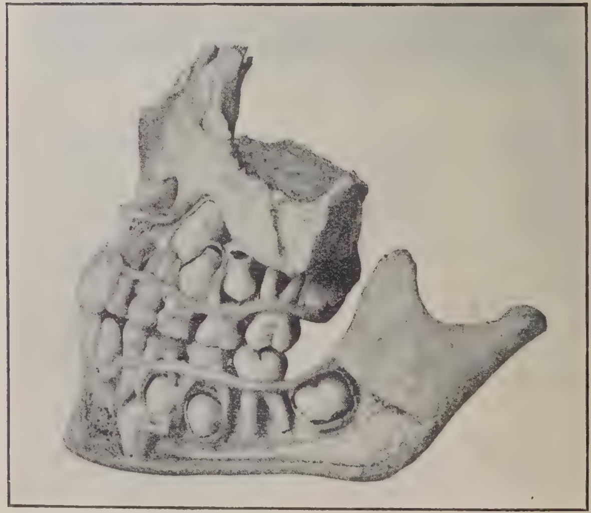
Second premolars. The formation of the root has commenced.

First molars. Roots nearly complete.



Seven years.

Fig. 10.



Nine years.

Fig. 11.

Second molars. The formation of the roots has commenced.

Calcification of the maxillary third molar would seem to commence at about ten years of age, and of the mandibular third molar somewhat later.

At the age of twelve years the incisors and usually the premolars are fully formed; the root of the canine is nearing completion; the second molar has the roots about two-thirds formed, and the crown of the third molar is calcified.

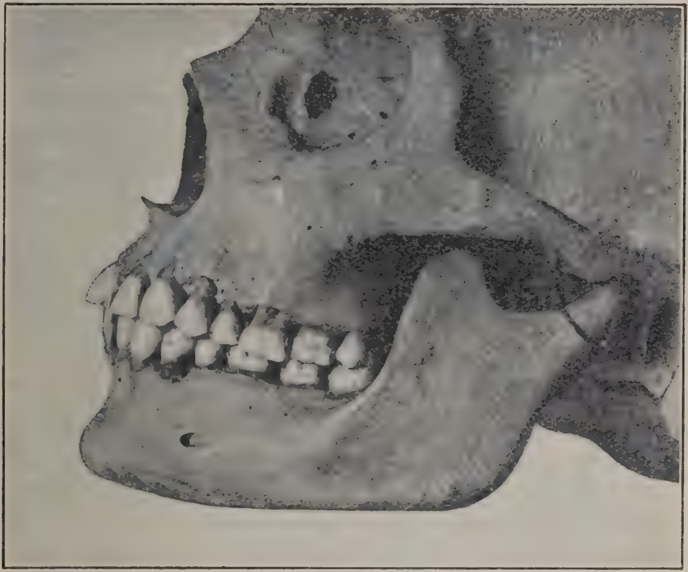


FIG. 12.

The formation of the second molars is complete about the sixteenth year, and of the third molars between the eighteenth and twentieth years. With the eruption of the third molars the second dentition is complete and should present the occlusion shown in fig. 12.

The specimens depicted above may be regarded as indicating approximately the normal amount of calcification at the periods specified, but there are wide variations from the normal as regards both development and calcification.

The diagrams shown in figs. 13 and 14 illustrate the amount of calcification of the deciduous and permanent teeth at various age periods.

In the process of dentition the periods of greatest activity occur during the early years of childhood. This fact cannot be too strongly impressed upon parents by those responsible for the medical care of children.

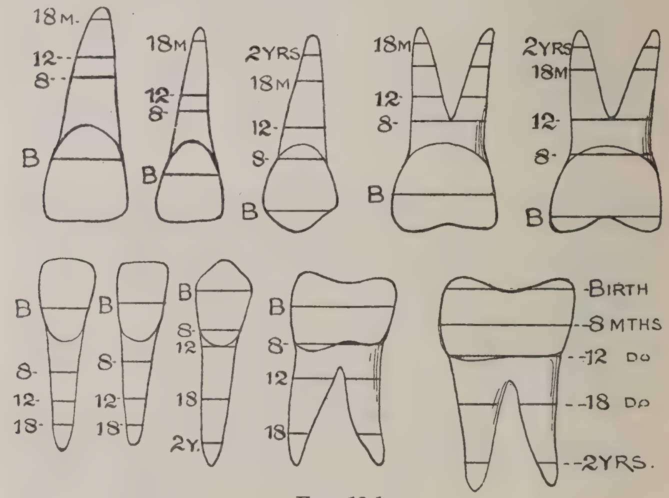


FIG. 13.[1]

(B) THE PROCESS OF ERUPTION[2]

A tooth lies deeply embedded in the tissues of the jaws during a considerable portion of its developmental period. As the time approaches for the performance of its natural functions, a movement to the surface commences and continues until the tooth emerges from the gum and assumes its position in the dental arch.

The precise manner in which the movement of the teeth in man is brought about presents a problem which has not yet been fully elucidated. But it seems probable that the mechanism which produces this movement in man is, in the main, identical physiologically with the mechanism which produces tooth movement in the lower orders of animals, and that by studying the process of eruption in the lower animals information will be obtained which will enable us to interpret the process in man.

A tooth is essentially a dermal appendage and any attachment which it may obtain with adjacent bony structures must be regarded as purely adventitious. The complex conditions attending the prolonged developmental stage of mammalian dentition are a necessary provision for the protection of teeth during the period of their formation.

---

[1] The material for the diagrams figs. 13 and 14 has been obtained from an examination of the skulls in the Odontological collection of the Royal College of Surgeons, and from Symington and Rankin's "Atlas of Skiagrams."

[2] For this section I am indebted to J. Thornton Carter.

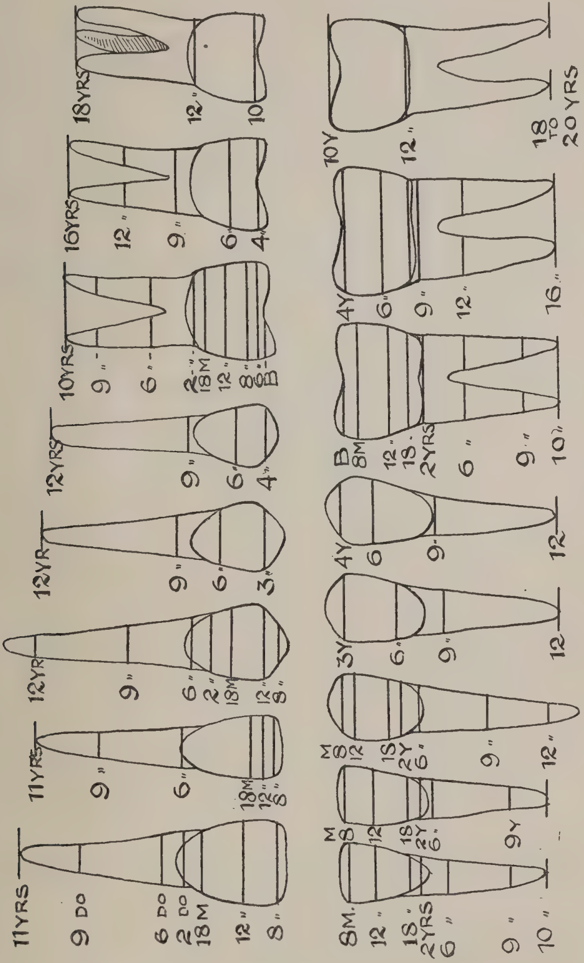


FIG. 14.

When an organ in any sensate creature moves from the position in which it was situated during its development and occupies a fresh position suitable for the performance of its natural functions, the physiological movement is always attributable to growth. But what is it that grows and causes the tooth to erupt? Is the movement due to the growth of the tooth itself, or to growth in the soft tissues constituting the tooth follicle, or to growth in the bony tissues surrounding the tooth?

If an attempt is made to find an answer to these questions by studying the jaws of mammalians only, great difficulties present themselves owing to the complex nature of the growth of the jaws and the consequent obscurity of the operation, which are the natural accompaniments of the specialization of the parts and of the organs connected with those parts.

For the purpose of studying tooth movement the teeth of fishes probably present the least difficulty. In most fishes teeth are produced in an endless succession of series. Each series has only a short functional existence and is replaced by rapidly developed successors. The mechanism of eruption is here constantly in operation unobscured.

Take, for example, the case of the dogfish. In the dogfish, as in all cartilaginous fish, the teeth are attached to the fibrous mucous membranes which cover the maxillary and mandibular cartilages and are not implanted in alveolar cavities, nor are they confluent with the substance of the jaws even where the external crust is ossified. The numerous teeth, in successive series, are constantly moving slowly upwards and over the border of the jaw. When each series reaches the outer margin of the jaw it is cast off, while new teeth, in equal proportion to those lost, are being developed in the mesoblastic tissues deep in the jaw. This regular upward procession of the teeth is plainly observable, and it only remains to ascertain precisely in what manner the movement is brought about.

It is clear that there must be a change in the position of the fibrous membrane to which the denticles are attached corresponding to the tooth movement, and, on examining the osteo-cartilaginous jaws, the fibres of the sliding membrane and the bases of the successional tooth germs, it will be seen that this change of position is due to absorption and deposition of bone at the margin of the jaw operating on the membrane.

The amount of ossification in and about the jaws of cartilaginous fishes is very slight, and extends a very little way into the cartilage. At the margin of the jaw, however, at or about that part where the bases of the erupted functional teeth rest on the jaw, there is a considerable thickening of osseous tissue which forms a crust of coarse and rapidly developed bone interspersed among the deeper fibres of the sliding membrane (fig. 15). This crust of bone—which is of a transitory nature, being constantly absorbed and deposited—is instrumental in causing the progressive movement of the sliding membrane. It is only at this part of the jaw that there is any intimate attachment of the sliding membrane to the tissues lying beneath, as may easily be observed by stripping the tooth-bearing membrane from the jaws.

The ossification at the margin of the jaw—which gives stability to the teeth during their short functional life, and protects the margin of the cartilage and the rapidly proliferating cells of its surface—affords the first phylogenetic evidence of an alveolar process in higher vertebrates.

When a functional tooth is shed, absorption of the underlying bone takes place and also absorption of the fibrous membrane at its outcrop. As a natural sequence to the absorption of the underlying bone and fibrous membrane, there is a rapid proliferation of cells at the margin of the cartilage, with formation of bony tissue over the same area. The newly-formed bony tissue operates on the fibres of the sliding membrane—which is poor in cellular elements and ill-adapted for active growth—and causes the membrane to move upwards and bear with it the next successional tooth. Concomitantly, there is renewed proliferation of the epithelial cells at the base of the tooth-band to give origin to the enamel organ of a new member for the series.

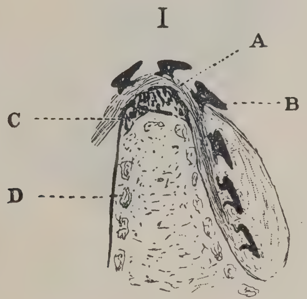


Fig. 15.—Section through jaw of dogfish. A, sliding membrane; B, tooth; C, bony crust; D, cartilaginous jaw.

This comparatively unobscured process of eruption in the dogfish probably furnishes us with the key to the process by which teeth are erupted in man. Throughout the animal kingdom connection of the teeth with the deeper fibres of the muco-periosteum of the gums seems to be an essential factor in the process of eruption. As teeth become more specialized and less numerous and require a longer formative period during which the creature uses its jaws to some extent, the growth of the alveolar plates produces a groove, and transverse septa form crypts, in order to provide the necessary protection. These changes necessitate an upward prolongation from the base of the dentine papilla to form a sac of connective tissue continuous with the deeper layers of the oral muco-periosteum (fig. 16).

Wherever a tooth is developed in a bony crypt below the surface of the jaw, a foramen will invariably be found leading from the tooth-bearing surface to the crypt, and transmitting a bundle of fibrous tissue continuous on the one side with the fibres of the periosteum, and on the other with those of the tooth sac (fig. 17). This bundle of fibrous tissue is known as the *gubernaculum*, but it must be clearly understood that its fibres exercise no traction in themselves and are merely sessile. The function of the gubernaculum is to afford a connection between the developing tooth and the membrane of the gums.

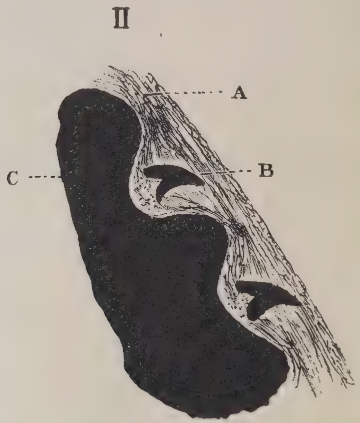


Fig. 16.—Diagram of jaw, showing septa between the individual teeth. The base of the dentine papilla is continuous with the oral muco-periosteum. A, muco-periosteum of jaw; B, tooth; C, bone of jaw.

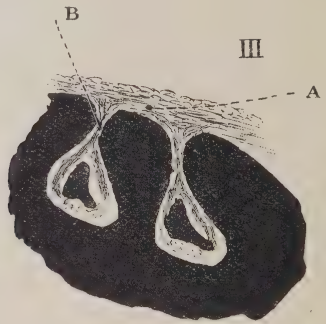


Fig. 17.—Diagram of jaw with teeth developed in bony crypts. The base of the dentine papilla is continued upwards around the tooth and communicates with the oral muco-periosteum by means of the "gubernaculum." A, muco-periosteum of jaw; B, gubernaculum.

In fibrous tissues poor in cellular elements (the tooth sac and gubernaculum are composed of such tissues), there is little adaptation for active and rapid growth. When, therefore, in the parts surrounding the tooth sac there is great activity owing to cellular proliferation, the passive tooth organs, which are supported by fibrous tissues, necessarily undergo a change of position, the direction and extent of the movement of the tooth sac being dependent on the degree of growth in the surrounding parts.

Thus we may conclude that in man, apart from actual growth of the tooth itself, the cause of eruption, or at least an active factor in producing eruption, is to be found in the disproportionate growth occurring in the tissues forming the tooth and the tissues surrounding the tooth.

The rapid growth of the osseous tissues surrounding the tooth carries upwards the more slowly growing fibrous connective tissues composing the tooth sac, so that as regards the movement of the teeth these fibrous connective tissues perform the same function as the sliding membrane in the dogfish.

A tissue or organ continues to grow up to the limit afforded by the resistance of the neighbouring tissues or organs. The lessening of this resistance through absorption causes a resumption of growth and cell-division, and these processes are continued until the normal equilibrium is re-established. The use of the term "resistance" must not be taken in its literal mechanical sense. Growth, with its associated phenomena, leads to compensatory changes in the neighbouring tissues; these changes are not a direct mechanical effect of its disturbance, but a highly complex physiological response to it.

In order that the tooth may emerge the tissues overlying the crown must be removed. The manner in which this is effected was first described by Wilson and Hill in their classical memoir on "The Development and Succession of Teeth in Perameles."[1] They state "The process of eruption is very clearly seen to be attended by the flattening out of the enamel epithelium covering the tooth crown and its conversion into squamous epithelium with concomitant formation in it of epithelial 'nests' or 'pearls' close to the tooth cusps. This nest formation also proceeds in the oral epithelium over the tooth. Eventually the epithelial pearls become placed quite near the surface and they then undergo rupture and disintegration, their cores of epithelial cells being lost and the tooth crown exposed."

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[1] *Quart. Journ Micros. Science,* 1897.

W. W. James has also described this phase of tooth eruption in Primates.[1]

In the hake this process of opening a track for the eruption of the tooth is delightfully simple. When the enamel cap is fully calcified, the process of eruption proceeds rapidly and is accompanied by certain marked changes in the enamel cells whose function has now been accomplished. An ingrowth of the cytoplasm of certain cells of the external epithelium takes place, and this ingrowth, inserting itself between the ameloblasts, divides them into groups or nests, frequently with no definite arrangement, but often causing them to become arranged in a series of loops. This invasion is most marked along a line corresponding to the area where the enamel cap will emerge in eruption.

When the apex of the crown is to be the point first to emerge, the cells of the external epithelium insert themselves between the bases of the ameloblasts over the whole vertex of the enamel organ and form a deep furrow. Sometimes there are two furrows running almost parallel and the ameloblasts lying beneath become changed, so that their nuclei stain with difficulty and their cytoplasm disappears in a sort of coarse vacuolation. The apex of the crown, however, is not invariably the point first to emerge from its investing epithelium, and when the tooth is going to erupt sideways the cells of the external epithelium traverse a small sector opposite which the rarefaction of the ameloblasts proceeds and permits the exit of the teeth.

Associated with these regressive changes there is an ingrowth of the oral epithelium, which, on reaching the enamel organ, appears to extend about it for some distance, inserting itself between the enamel cells and the surrounding connective tissues; this epithelial ingrowth often extends down to the limits of the cells responsible for the enamel cap, and at first consists of a narrow band of cells, two or three deep, but rapidly increases in size until it forms a large epithelial mass in contact at one end with the enamel organ and at the other end continuous with the cells of the oral mucous membrane. Cytolysis takes place in the centrally lying cells, forming a way along which the tooth proceeds to erupt.

In venomous snakes, the ingrowth of epithelium to afford a path for the eruption of the tooth also serves to bring the poison fang into relation with the ducts of the poison gland. In the Australian Black Snake (*Pseudechis*) a duct passes from the gland—the modified parotid—forward along the side of the upper jaw and opens into a pocket lying just anterior to the bases of the poison fangs. This pocket is formed by a proliferation of epithelial cells which anteriorly extends downwards into the connective tissues in a crescentic form and into which the poison ducts open on its anterior surface. From the posterior margin of this crescentic ingrowth a band of epithelial cells passes backwards which eventually bifurcates, sending down a separate ingrowth to the developing poison fangs which lie parallel in a double series. This epithelial ingrowth is quite distinct from the true tooth band. When a functional tooth is shed its successor proceeds along this epithelial track and moves forward until it reaches the pocket, where it becomes anchylosed by its base to the maxilla with the groove on its anterior surface in contact with the opening of the duct of the poison gland. In this manner an alternating succession of poison fangs is provided similar to that of the vipers.

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[1] *Proc. Roy. Soc. Medicine*, 1909.

(C) THE ERUPTION OF THE DECIDUOUS TEETH

The normal signs of approaching eruption are an increased flow of saliva and an inclination on the part of the child to bite at any tangible object. A healthy child will often cut its teeth without the slightest trouble, but more often the gums are a little tumid, tense, and shining over the erupting tooth, the local condition being accompanied by slight irritability, restlessness, and a rise of temperature.

The order and date of eruption vary considerably within normal limits. For example, A. T. Spanton (*British Medical Journal*, June 3, 1907, p. 1362) examined 200 healthy breast-fed children of normal parents to ascertain which tooth of the deciduous set was the first to appear. The summary of his investigations is given below:—

TABLE SHOWING THE TOOTH WHICH WAS THE FIRST TO APPEAR THROUGH THE GUM IN THE CASE OF 100 BOYS AND 100 GIRLS.

First tooth or teeth to appear through the gum	(*a*) 100 Boys	(*b*) 100 Girls
Mandibular right first incisor	39	32
Mandibular left first incisor	32	39
Both mandibular first incisors together	14	15
Maxillary right first incisor	10	2
Both maxillary first incisors together...	5	6
Maxillary left first incisor	0	6

The average age when the first tooth erupted was boys 252 days, girls 221 days.

These figures tend to show that, on the average, the eruption of teeth begins in girls thirty-one days earlier than in boys.

The eruption of the teeth in breast-fed and hand-fed children respectively has been investigated by Alice Calman.[1] The figures quoted show that the eruption of the teeth occurs earlier and proceeds more regularly in breast-fed than in hand-fed children.

Authentic statistics as to the order and time of eruption of the deciduous teeth are not available, but the following periods may be taken as approximately correct:—

Mandibular first incisors, fifth to eighth month.
Maxillary first and second incisors, seventh to tenth month.
Mandibular second incisors, tenth to twelfth month.
First molars, twelfth to fourteenth month.
Canines, fourteenth to twentieth month.
Second molars, twentieth to thirtieth month.

As a rule the teeth erupt in pairs or groups, and between the eruptions there is an interval which varies from two to five months, the interval becoming greater between the later eruptions.

Eruption of teeth before birth is extremely rare. When this occurs the teeth are usually imperfectly developed and loosely attached to the muco-periosteum, but occasionally they are well formed and attached to normal alveoli.

(D) THE ABSORPTION OF THE DECIDUOUS TEETH

The removal of the deciduous teeth is brought about by the action of multi-nucleated cells possessing an osteoclastic function. In this way the root is gradually removed and the crown remains as a hollow shell over the position of the erupting permanent tooth. Intervening between the deciduous and the permanent tooth is a soft vascular substance which has received the name of the "absorbent organ."

If a microscopical section is made of a deciduous tooth with the absorbent organ in position, it will be seen that the soft vascular part is composed of a mass of cells, those nearest to the dentine being multi-nucleated and fitting into the cup-shaped excavations in the dentine. Fig. 18 is a drawing of the absorbent cells in contact with the dentine. It will thus be seen that the so-called absorbent organ is only a mass of cells, some of which act as osteoclasts. Where absorption of a permanent tooth occurs, for example, the absorption of the posterior root of the mandibular second molar by the impact of the mandibular third molar, a section through the absorbed portion will show a condition precisely similar to that found in an absorbed deciduous tooth. In specimens of rarefying periodontitis, Howship's lacunæ filled with the characteristic giant cells can be seen. The disappearance of the tooth tissue of the deciduous tooth undoubtedly depends upon the presence of these multi-nucleated or osteoclastic cells, but it is not clear how they perform their work. Some writers suggest that the cells send out amœbiform processes, others that they secrete an acid which dissolves the tooth substance, the remaining organic substance being removed by phagocytic action. What determines the presence of the so-called absorbent organ is as yet unknown. There is reason to believe that the absorption of deciduous teeth is closely associated with a forward movement of their permanent successors. The parts of the deciduous teeth removed are those obstructing the path of the erupting permanent teeth. When the unerupted permanent tooth is in a normal position the whole of the root of the deciduous tooth obstructs the passage and is duly removed, but when the permanent tooth occupies an irregular position only a portion of the deciduous tooth bars its onward passage and that alone is removed. Again, in cases where the permanent teeth fail to erupt the roots of the deciduous teeth remain intact. Absorption of the deciduous teeth does occasionally occur in the absence of the

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[1] Annual Report, Loughborough Junction Maternity and Child Welfare Centre, 1919-1920.

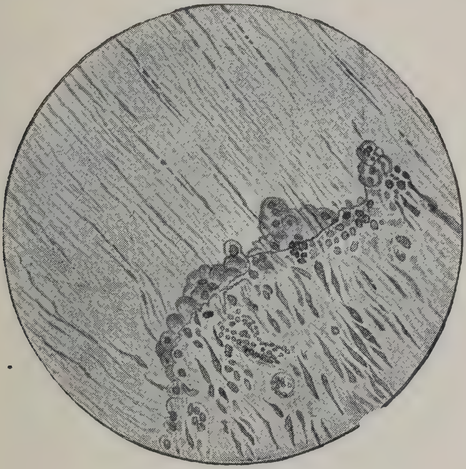

FIG. 18.[1]

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[1] From a drawing by J. Howard Mummery.

permanent teeth, and from this it is argued that the absorption of the deciduous teeth cannot be connected with the permanent teeth. In such cases, however, there is invariably a history of gingivitis and septic periodontitis. When the pulp of a deciduous tooth is septic the process of absorption seems to be greatly retarded and in some instances to be arrested.

Changes in the Pulp of Deciduous Teeth undergoing Absorption.—An examination of a deciduous tooth which is in the process of absorption will show that the large nerve trunks have been destroyed and that the pulp is fibrous and vacuolated. It will also be seen that at the terminal margin of the pulp there is a well-marked layer of fibrous tissue (see fig. 19).

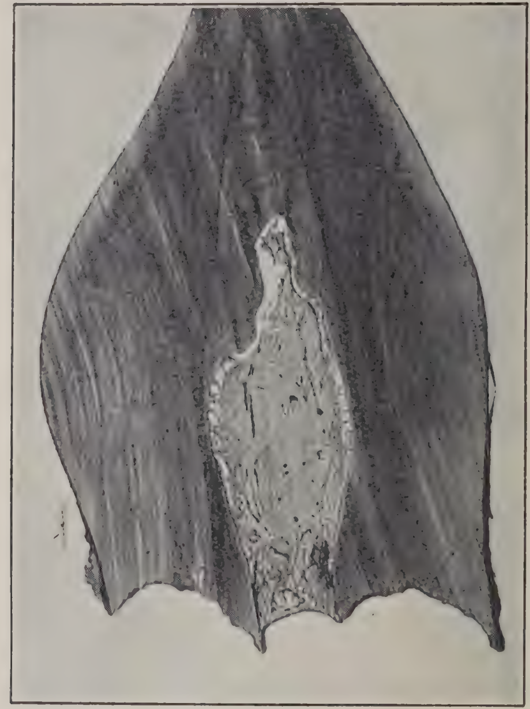

FIG. 19.

(E) THE ERUPTION OF THE PERMANENT TEETH

With the permanent teeth, as with their predecessors, there appears to be no fixed rule either for the order or for the time of eruption.

S. Cartwright published[1] a detailed account of over 3,000 cases which he had examined, and the figures recorded clearly indicate not only that there is a considerable variation in the ages at which the various teeth erupt, but also that the order of eruption varies. An examination of about 7,000 persons was undertaken by Dietlin,[2] and his records show similar variations.

C. Röse has compiled statistics comprising particulars of over 40,000 children of both sexes.[3] His conclusions are:—

(*a*) That the time of eruption varies within wide limits, variation being least in the first permanent molars and most in the canines and premolars.

(*b*) That in the female sex the teeth erupt on an average four and one-half months earlier than in the male sex. The difference is smallest in the eruption of the first permanent molars, and largest in the canines.

(*c*) That the time of eruption varies in different races.

(*d*) That eruption occurs earlier in the children of the leisured classes than in the children of the working classes.

From clinical experience it would seem that the first permanent molars and the incisors erupt in somewhat rapid succession, and that their eruption is followed by a distinct period of rest often extending over two years. After this rest, another period of eruption occurs, and the premolars, canines and second molars appear. The approximate order and date of eruption of the permanent teeth are shown below.

Mandibular first molars	6 to 8 years.
Maxillary first molars	
Mandibular first incisors	
Maxillary first incisors	
Mandibular second incisors	
Maxillary second incisors	
Maxillary first premolars ...	10 to 11 years.
Mandibular first premolars	11 to 12 years.
Maxillary second premolars	
Mandibular canines	
Mandibular second premolars	12 to 13 years.
Maxillary canines	
Mandibular second molars	
Maxillary second molars	
Third molars	20 to 25 years.

The time of eruption of the third molars depends, to a great extent, upon the amount of space in the arch. With all the teeth present the figures given in the above table probably represent the average age of appearance. The early removal of second molars will accelerate the appearance of the third molars which may erupt as early as the fourteenth year, and early removal of the first molars may produce the same effect.

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[1] *British Journal of Dental Science*, May, 1857.

[2] *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde.* (Translated in Ash's *Quarterly Circular*, Sept., 1895, p. 353, and Dec., 1895, p. 484.)

[3] *Deutsche Monatsschrift für Zahnheilkunde*, August, 1909.

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CHAPTER II

Pathological Dentition

Disorders associated with the Process of Teething—Retarded Eruption—Partial Eruption—Impeded Eruption—Failure of Eruption

(A) DISORDERS ASSOCIATED WITH THE PROCESS OF TEETHING

(1) General

Certain general disorders frequently occur about the time of teething and considerable diversity of opinion exists as to the exact relationship between these disorders and the process of teething. Formerly illnesses at this period appear to have been readily regarded as a natural sequence to the process of dentition, whereas the tendency now seems to be in the opposite direction, and in the search for the cause of general disorders dentition is often ignored.[1]

In an endeavour to arrive at the actual facts of the case it is well to remember that weakly children, especially if they have been hand-fed, are prone to general disturbances, and that local trouble in the mouth probably tends to aggravate such conditions. Further, general disturbances occurring during teething are often wholly traceable to other causes; for example, gastro-intestinal troubles may be due to defective feeding, convulsions to a similar cause, and respiratory affections and otitis media to the presence of adenoids. But after due allowance has been made for all known causes there still remain cases of general disturbance which are coincident with dentition, and which cannot be accounted for if they are not to be attributed to the dental condition. There is naturally extreme difficulty in placing dentition in causal relationship with such disorders, because we have to rely mainly on clinical observation; but it seems only reasonable to assume that such a relationship does exist when the occurrence of a disorder not only coincides with dentition but has a special tendency to coincide repeatedly with the eruption of successive teeth.

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[1] In compiling this section I have been greatly assisted by G. F. Still's work on "Common Disorders and Diseases of Childhood," Third Edition.

In referring to this question, Still expresses the opinion that there is too great a tendency to assume that because dentition is a physiological process it is incapable of causing disturbance of health. He points out that pregnancy is also a physiological process, and no one would deny that pregnancy may disturb the health in many ways. Still states that, with increasing experience, he is inclined to enlarge rather than to restrict his conception of the *rôle* which dentition plays in the production of disturbances of various kinds during infancy.

Clinical observation clearly establishes the fact that irritation often exists in the mouth during the period of eruption. In most cases the irritation is due to direct pressure of the tooth upon the superincumbent tissue. J. W. White points out that the aperture at the end of the growing tooth is large, and undue resistance of the gum tissue would lead to pressure on the nerve trunks entering the pulp. White supports his view by clinical evidence afforded by cases in which there are no local signs of inflammation and in which constitutional disturbance disappears when the gum is lanced.

The following general disorders may, in Still's opinion, *be traceable to dentition:*—

(*a*) Loss of appetite.

(*b*) Failure to gain weight or diminution in the rate of gain. This condition is frequently associated with dentition and may be attributable to the tenderness of the gums. The deficiency in weight is, however, made up in the intervals between the eruption of the different teeth.

(*c*) Sleeplessness.

(*d*) Instability of the nervous system. Infants troubled with coming teeth often show a tendency to convulsive twitchings, upward rolling of the eyes, slight strabismus, although not losing consciousness. In children of neuropathic heredity, or who, through rickets, are predisposed to infantile convulsions or epilepsy, dentition appears to be distinctly a time of peril. Still has seen attacks of *petit mal* which were much aggravated by dentition and ceased when the last tooth was cut.

(*e*) Rise of temperature. This may occur without the presence of an inflamed condition of the gums, and is probably in most cases purely reflex and analogous to cases in which neurotic children will show a rise of temperature with any excitement, such as a visit to a pantomime; the rise of temperature with the worry of an erupting tooth is thus part of the induced instability of the nervous system.

(*f*) Attacks of vomiting sometimes occur, with little or no disturbance of the bowels, shortly before the appearance of a tooth.

(*g*) Bronchitis and diarrhœa. Although children are prone to these conditions, there are cases, nevertheless, which seem to be distinctly nervous and traceable to reflex influence from the teeth. That such a condition could exist is quite conceivable since the bronchial catarrh of the asthmatic child and the lienteric diarrhœa (the nervous diarrhœa of Trousseau) are admittedly dependent in some instances upon nervous influence, often quite remote from the organs affected.

(*h*) Violent screaming attacks, independent of any digestive disorder and not obviously due to any pain, are sometimes associated with dentition. This condition is, however, uncommon.

(*i*) Photophobia. This may be so pronounced "that the child will cover his eyes with his hands or bury his face in the pillow or against his mother's breast, when exposed even to the moderate light of a sunless day." The photophobia may be so extreme that the child cries or screams violently when exposed to ordinary daylight.

(*j*) Head retraction. Still has seen this symptom causing suspicion of meningitis where teething seemed to be the only cause. This head retraction is often present in cases of increased tension in the middle ear, but he remarks that there has been nothing to suggest ear trouble in the cases he has seen associated with dentition.

(*k*) A rare disorder which is closely related to dentition is *spasmus nutans*, or head-nodding with nystagmus. This disorder is so distinctly coincident with dentition in its onset and cessation, and is so definitely aggravated by the eruption of a fresh tooth, that there would seem to be a causal relationship between the two.

Treatment.—The treatment of these conditions lies within the province of the general practitioner, but the dental surgeon may be consulted with a view to lancing the gums. This operation, if considered necessary, should be performed as follows: "A curved bistoury should be used, and, in order to prevent injury to surrounding parts, a strip of lint should be wrapped round the knife so that only $\frac{1}{2}$ in. is exposed. The technique of the operation is quite simple. The child should be placed on a pillow on the lap of the nurse, who should be seated on a chair opposite the operator, and with her back towards the source of light which should come preferably from a north window. The operator should seat himself facing the nurse, with the end of the pillow supporting the child's head in his lap. He thus commands the territory of operation, and, by holding the child's head, can guard against any sudden movement. The hands and the body of the child must be firmly held by the assistant. The lancet is then passed through the overlying tissue until it is felt to come into contact with the enamel surface, and the tissue divided sufficiently to allow the tooth to erupt without resistance" (Kirk).

The best method is to make two semilunar incisions which meet at their extremities, and remove the intervening portion of gum with a pair of tenaculum forceps. Objection has been raised to the use of the lancet while the tooth is still considerably below the surface, on the ground that cicatricial tissue offers greater resistance to the progress of the tooth than fibrous tissue; but as cicatricial tissue is of a lower degree of organization than normal fibrous tissue and therefore more easily disintegrated by pressure, this objection is not tenable.

(2) LOCAL

Simple Stomatitis.—The stomatitis is usually confined to the neighbourhood of the erupting tooth, and is characterized by intense redness and swelling, the mouth at the same time being hot, the child fractious, restless, and in evident pain. The temperature may reach 104° or 105° F.; but it should be remembered that pyrexia in children readily supervenes upon slight causes.

Ulcerative Stomatitis.—In these cases the gums become hot, swollen, and painful, and these symptoms are especially marked over a certain tooth. Ulceration supervenes, and may extend to the gum around any other tooth already erupted. The ulcers thus formed have a sloughy appearance; the breath is fœtid and hot; the flow of saliva is increased, and the child rejects its food. In addition, there is marked pyrexia and, at times, gastro-intestinal disturbance. Ulcerative stomatitis is due to local infection, and may often be traced to dirty feeding bottles or neglect of oral hygiene. It is interesting to note that the local disturbances associated with dentition decrease in proportion to the care exercised in dealing with oral hygiene.

Treatment.—Treatment of the local condition consists in paying strict attention to the hygiene of the mouth and the application to the gums of hydrogen peroxide; a brisk purge should also be given. In cases where the ulceration shows signs of spreading, the application of an escharotic is advisable. The patient should be isolated.

Superficial Cysts.—Small cysts occasionally form over erupting teeth, but they do not interfere with eruption. On being punctured they give forth a small quantity of clear fluid. These cysts are lined with " epithelium many layers thick, spheroidal at the growing periphery, and tending to become stellate on the cyst side " (J. G. Turner). Occasionally, the cyst is of abnormal size, indeed, sufficiently large to attract the attention of parents. Under these conditions, puncturing does not, as a rule, bring relief, and it is necessary to remove the gum covering the tooth.

The local disturbances accompanying eruption of the permanent teeth are chiefly associated with the third molars, especially the mandibular. When a mandibular third molar erupts the anterior cusps appear first, and the small portion of gum which lies over the posterior part of the tooth occasionally ulcerates from constant pressure of the antagonizing tooth. The ulceration may become extremely painful and the adjacent tissues may become involved. The patient complains of pain in the region of the fauces, but perhaps the most tender point is where the mucous membrane of the gum becomes continuous with that of the cheek. This condition is best relieved by free incisions, care being taken that the knife divides all the tissues overlying the buccal surface of the tooth. Should this treatment not bring relief, it is advisable to remove the process of gum that is covering the tooth; this can be accomplished with the scalpel and forceps. In addition, fomentation of the inside of the mouth should be advised, and hot water at a temperature just bearable is perhaps as comforting an application as any, although decoction of poppy-heads is often to be recommended, the opium contained in the poppies acting as a local anodyne. Suppuration may supervene, and in that case the offending tooth must be removed, otherwise trismus may occur. The trismus is said to be produced in most instances by spasm of the masseter muscle, due to reflex irritation; but it is more than probable that the trismus is generally caused by spread of inflammation to adjacent tissues. The insertion of the temporal and pterygoid muscles and the intervening cellular tissue may, by a process of continuity of inflammation, become affected, and produce closure of the jaws. The latter explanation of the occurrence of the trismus also seems to be more in harmony with the clinical aspect of the majority of cases met with, for, in nearly all of them, the patient is able to effect slight movement in the articulation, which would not be possible if the trismus were due to tonic spasm of the masseter muscle. Moreover, the mobility of the articulation increases as the inflammatory symptoms subside. It appears probable, therefore, that in most cases of trismus the condition is to be attributed to the inflammatory process, but no doubt instances may occur where the closure of the jaw is due to a tonic spasm of the muscles of mastication. The treatment of the above condition is to remove the erupting tooth.

The mandibular third molar, when impacted, may give rise to severe odontalgia in the second molar, the pressure from the erupting tooth causing absorption of the posterior surface of the second molar, leading to exposure of its pulp. The absorption in these cases is not due to the pressure of the crown of the third molar against the cement or enamel of the second, but to multi-nucleated cells which are developed at the point of contact, and which perform the function of osteoclasts in removing the obstructing tissues. In these cases the second molar should be removed. For further reference to misplaced third molars see Chapter V.

(B) RETARDED ERUPTION

Rickets.—In children suffering from rickets, the eruption of the teeth is sometimes considerably retarded, and it is not uncommon for the advent of dentition to be delayed until the commencement of the second year. Retarded eruption of the permanent teeth is also met with in those who have suffered from rickets in infancy. The following case recorded[1] by Montague Hopson is fairly typical of the effect of rickets on dentition. The patient was a female aged 49 years. The first deciduous tooth appeared at 14 months; the others appeared after long intervals. Two deciduous incisors were shed at the age of 11 and four or five others were extracted at the age of 23. At the age of 40 the remaining deciduous teeth were removed, the following permanent teeth being in position: $\begin{array}{r|r} 76 & 67 \\ \hline 7654 & \end{array}$ Owing to advanced caries the $\begin{array}{r|r} 76 & 6 \\ \hline 76 & \end{array}$ were removed. Three years later the maxillary left third molar had partly erupted, and radiograms showed the presence of the following unerupted teeth: $\begin{array}{r|l} 8\ 54321 & 12345 \\ \hline 8\ \ \ \ 321 & 12345 \end{array}$; in addition there were two supernumerary teeth in the premaxillæ. The mandibular left molars were undeveloped. The retarded eruption associated with rickets is attributed by some observers to thickening of the tooth sac. The fact that fibrous odontomes are formed in rickety animals supports this view.

The specimen shown in fig. 20 would seem to throw some light on the subject. The animal, a cat which died at the age of three years, had suffered from pronounced rickets. The only teeth present in the mouth at the time of death were an incisor in the maxilla and an incisor in the mandible; the cusps of a premolar and a molar in the maxilla and a molar in the mandible had also appeared.

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. xiv, p. 24.

Considerable difficulty was experienced in removing the outer alveolar plate to expose the teeth. The bone bordering the oral cavity was of a hard, compact nature, and the premolars instead of resting in crypts were found to be welded, as it were, to the bone, the latter being quite ivory-like in character. The maxillary canine rested in a crypt the walls of which were of a hard, compact nature.

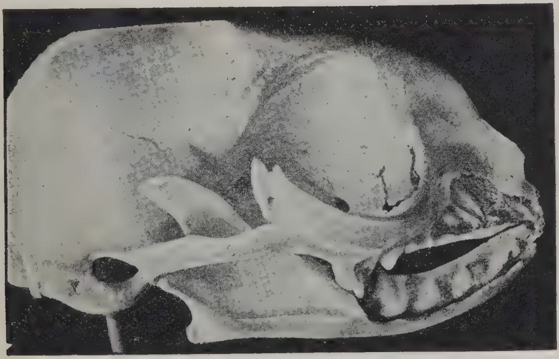

FIG. 20.[1]

Syphilis.—The general effect of syphilis on eruption is to delay the process, but in a few instances syphilis may accelerate eruption.[2] (For further details of the effect of syphilis on dentition see p. 87.)

Idiocy.—The teeth of micro-cephalics and cretins are usually small, and eruption is considerably delayed. In cretins the eruption of both the deciduous and permanent dentitions is often delayed and may also commence irregularly, though in the subsequent growth of the permanent series the trend is towards eventual perfection of the dentition.

It is interesting to note that the administration of thyroid extract, which assists growth in general, also promotes the eruption of the teeth. In cases where no general improvement follows the administration of thyroid, there is no effect on dentition.[1]

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[1] From *Trans. Odonto. Soc.*

[2] See article by Dr. Cavallaro on "Syphilis in its Relation to Dentition," *Cosmos*, November, 1908, to February, 1909.

Retardation in the Eruption of Individual Teeth.—Occasionally dentition occurs at the normal periods with the exception of individual teeth which appear only after a considerable interval.

In the maxilla the eruption of the canine may be delayed until middle life; for example, in two cases these teeth did not appear until the age of thirty-five and forty years respectively. Retarded eruption of the canines is much more common in the female than in the male. The premolars are, at times, retarded in their eruption. In one patient under observation the maxillary right second premolar did not appear until the age of 35. The third permanent molar is frequently retarded and may not erupt until quite late in life.

In the mandible the eruption of the first and second premolars is frequently retarded, and the appearance of these teeth may be delayed for two or three years. The second premolar is more frequently retarded in its eruption than the first. The mandibular third molar may erupt at any time after puberty. In one case under observation the mandibular right second incisor did not appear until the fourteenth year.

When a tooth appears late in life the process must be looked upon not as an eruption but as an uncovering of an embedded tooth through atrophy of the superincumbent tissues. In these cases septic infection of the tooth sac may occur, and the condition may be mistaken for malignant disease.

(C) PARTIAL ERUPTION

In the deciduous series it is occasionally observed that the molars have only partially erupted, the process having been prematurely arrested. The molars occlude, but the upper incisors may overlap the lower teeth and impinge on the gum. When the first permanent molars have erupted the " bite " becomes more open and a space is formed between the deciduous molars as seen in figs. 21 and 22. The condition is not infrequently associated with a history of rickets.

This partial eruption of the deciduous molars may be limited to the first molars, so that with the eruption of the second molars the first molars will not occlude.

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[1] " Teeth of Micro-cephalics and Cretins," by J. G. Turner, *Trans. Odonto. Soc.*, vol. xxxiv, p. 1.

Partial eruption of one deciduous molar is rare (fig. 23). In two cases the mandibular second molar was affected and the first permanent molar had tilted forwards. In one case there was a history of injury to the soft tissues from the use of forceps at birth.

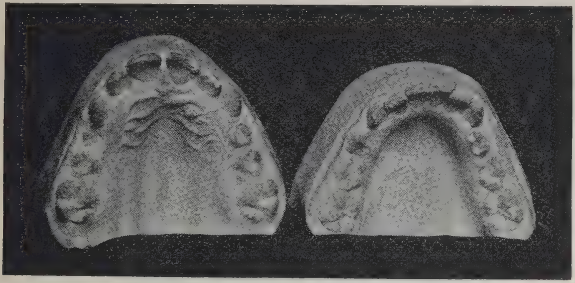

FIG. 21.[1]

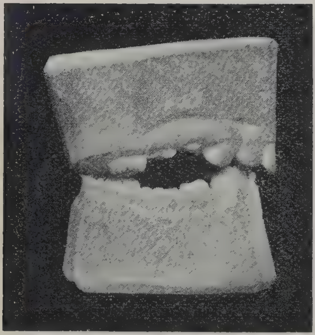

FIG. 22.[1]

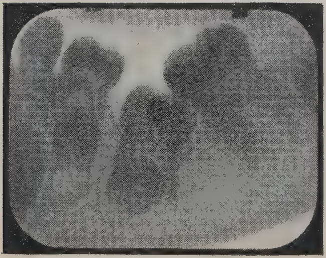

FIG. 23.

In the permanent dentition partial eruption of the premolars or of the molars may occur, and in such cases there is frequently a history of retarded eruption. In fig. 24 is shown a case where the mandibular right first molar was partially erupted.

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[1] From *Proc. Roy. Soc. Med.*

An instructive case of partial eruption of teeth has been recorded by A. T. Pitts.[1] A male, twenty-three years of age, presented the following condition: on the left side of the mandible the first premolar was missing, the second premolar and first and second molars were partly erupted, the crowns of the teeth alone being exposed; on the right sight the first molar in the mandible was carious, but sufficient of the crown remained to show that it had

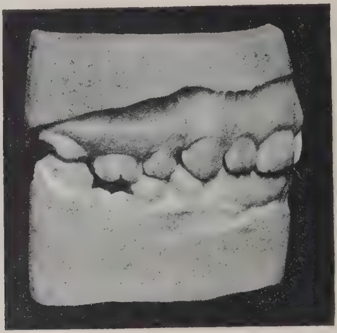

FIG. 24.[2]

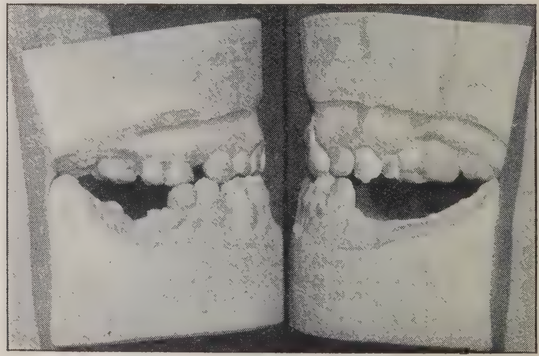

FIG. 25.[2]

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. v, p. 147.

[2] From *Proc. Roy. Soc. Med.*

only partly erupted, while the maxillary second molar showed a similar condition (see fig. 25).

The radiogram of the mandible (fig. 26) showed that the partly erupted teeth were fully formed, but that the body of the bone in this region was insufficiently developed. This case would seem to suggest that the eruption of the teeth is closely associated with the growth of the body of the bone, and that when growth is insufficient neither the formation of the root nor the development of the bone around the teeth suffices to bring about the eruption of the teeth.

Teeth which are partly erupted are liable to become the seat of chronic sepsis. In the fully erupted tooth the "gingival trough"[1] is shallow, in the partially erupted tooth it is deep (see diagram, fig. 27).

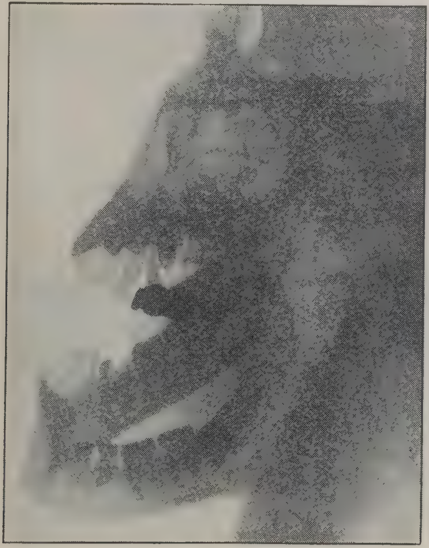

FIG. 26.[2]

A deep "gingival trough" encourages the accumulation of septic material which may cause injury to the periodontal membrane and lead to changes in the hard tissues of the tooth, as illustrated in the case shown in fig. 28.

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[1] The furrow around the tooth formed by the fold of gum has been named by Hopewell-Smith the "gingival trough." This term will be used throughout the following pages.

[2] From *Proc. Roy. Soc. Med.*

(D) IMPEDED ERUPTION

This condition may arise in a variety of ways. Premature loss of a deciduous tooth may be the indirect cause of impeded eruption of its successor owing to the tilting together of the adjacent teeth. The obstructing agent may be a supernumerary tooth, or may be a persistent deciduous tooth which has become wedged in consequence of the approximal teeth having inclined towards each other.

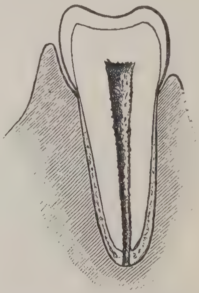

Fig. 27.—The "gingival trough" in the fully erupted tooth is shown on the right side, that of the partially erupted tooth on the left side.

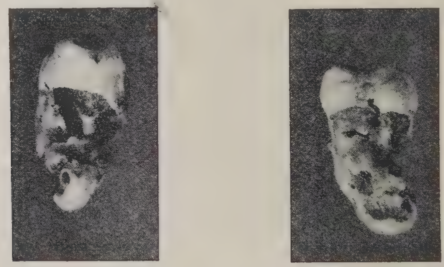

Fig. 28.—Mandibular left second molar showing extensive destruction of the root. From a paper by A. Hopewell-Smith. *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. iii, p. 9.

Geminated deciduous teeth may act as impediments, and a case has been seen in which the mandibular first incisor was prevented from erupting because absorption had taken place only at that part of the root corresponding to the deciduous first incisor, leaving the portion of the root corresponding to the second incisor firmly embedded and unabsorbed.

When the deciduous first incisors persist after the eruption of the permanent second incisors the presence of supernumerary teeth may be suspected. In such cases the position and also the condition of the permanent incisors and supernumerary teeth should be ascertained by radiography. If the permanent teeth are found to be normal in shape the supernumerary teeth, together with the deciduous incisors, should be removed, the interval between the second incisors being retained until the permanent first incisors have erupted. Should there be insufficient room in the arch for the permanent first incisors the necessary space should be obtained by the extraction of teeth. On the other hand, if the roots of the permanent first incisors are found to be deformed it is very improbable that they will assume a normal position in the arch, and if the supernumerary teeth are of fairly good shape the best course is to allow the supernumerary teeth to erupt and then remove the unerupted incisors, provided that the individual is a man; but if the individual is a female, or if the supernumerary teeth are badly shaped, these teeth together with the permanent incisors should be removed and a denture adapted.

(E) FAILURE OF ERUPTION

In the section dealing with retarded eruption reference was made to the fact that teeth may fail to erupt in those who have suffered from rickets. Teeth which have been injured during the period of growth, or have developed in abnormal positions, may remain embedded in the bone.

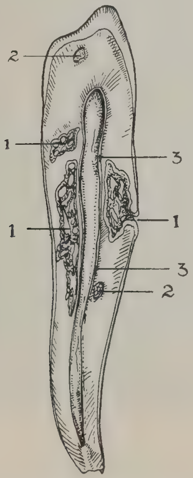

FIG. 29.[1]—1, absorption areas well marked; 2, absorption areas commencing; 3, secondary dentine.

Pathological changes of structure often occur in teeth which have failed to erupt. The changes consist in an absorption of the dentine and a replacement of the lost dentine by tissue of an osseous character. A case illustrating these changes is described by Williger.[1] A maxillary unerupted canine was removed, and, on section, spots were visible as if the dentine were perforated (fig. 29).

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[1] By permission from Ash's *Quarterly Circular.*

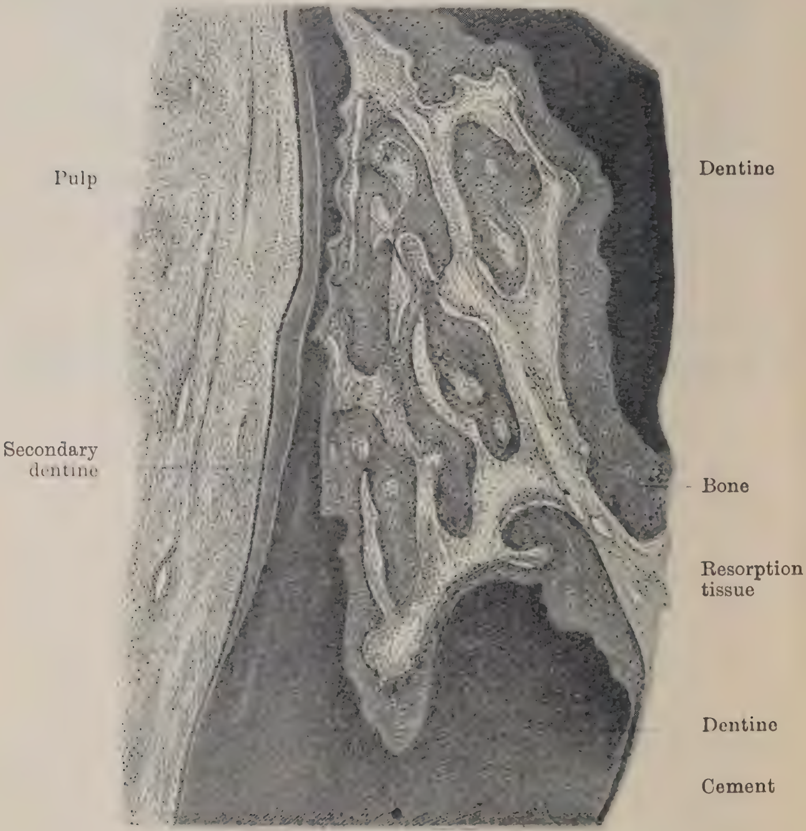

FIG. 30.[2]

On microscopical examination the dentine was seen to have been absorbed and in great measure replaced by osseous tissue (fig. 30). The absorption was due to a growth of tissue from the periodontal membrane and not from the pulp. The presence of secondary dentine on the walls of the pulp canal showed that the pulp had reacted in the same manner as in other injuries of the dentine.[1]

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[1] Translated in Ash's *Quarterly Circular*, January, 1909, from the *Correspondenz-Blatt für Zahnheilkunde*.

[2] By permission from Ash's *Quarterly Circular*.

An interesting case is recorded by A. W. Baker[2] of an unerupted mandibular third molar which showed definite changes. A sinus led to the tooth, and it is probable therefore that there had been a septic infection of the tooth crypt. The tooth showed considerable hyperplasia of the cement, a thick layer of this tissue having been deposited external to the enamel and the original cement, as shown

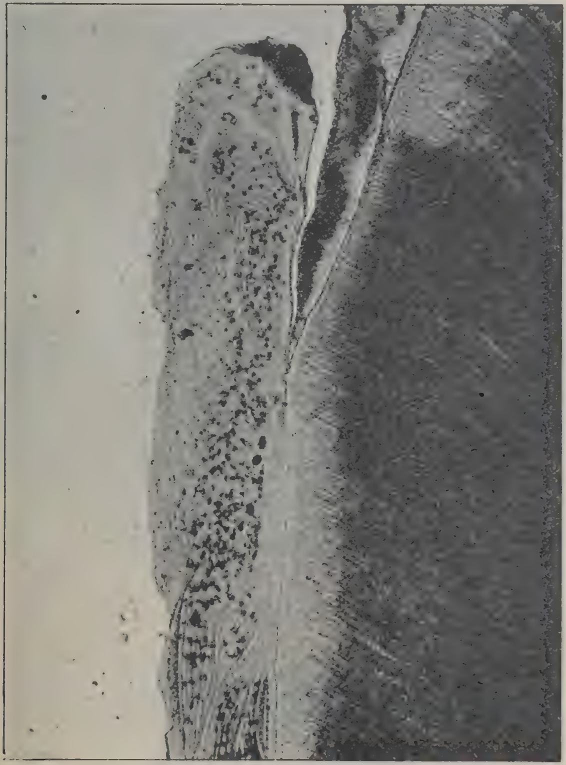

FIG. 31.[3]—Longitudinal section. × 50.

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[1] In connection with this subject, see papers by A. Hopewell-Smith, *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. iii, p. 9; and by J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxv, p. 66.

[2] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. i, p. 130.

[3] From *Proc. Roy. Soc. Med.*

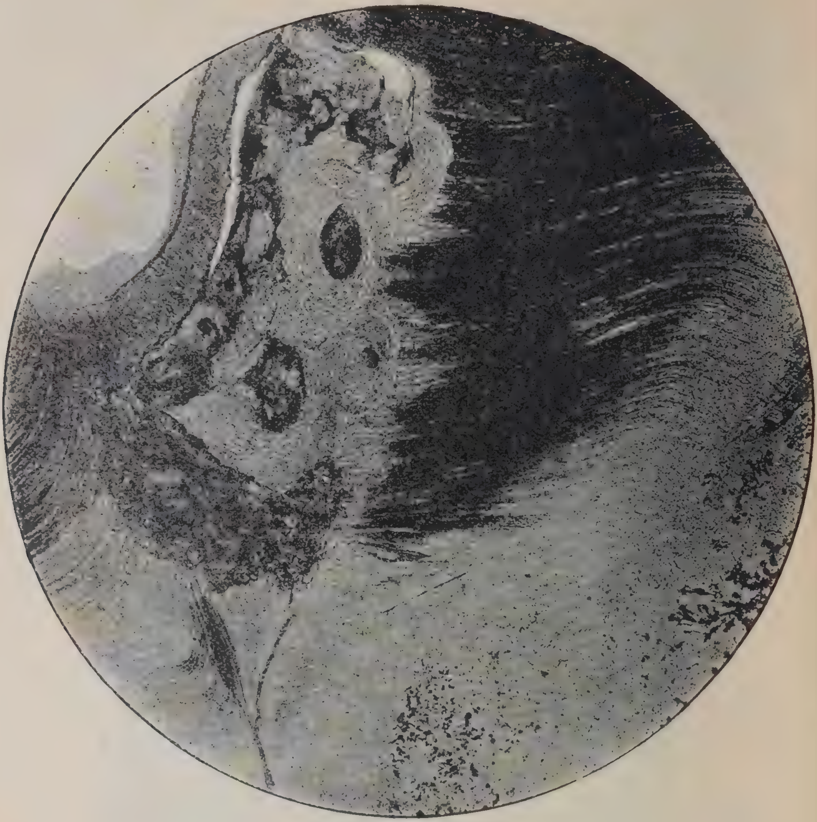

Fig. 32.[1]—Transverse section. × 60.

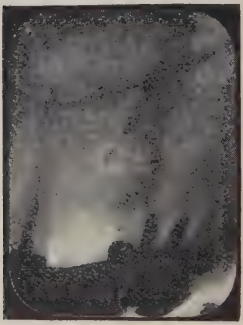

Fig. 33.

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[1] From *Proc. Roy. Soc. Med.*

in fig. 31. At one part of the root the original tissue had been removed and, in parts, replaced by compact bone (fig. 32).

In Williger's case, quoted above, there is no mention of the presence of sepsis, but in the cases which have come under my personal observation septic infection has always been present, and the changes which occur in misplaced teeth are probably the result of long-continued sepsis of mild intensity.

In the case illustrated in fig. 33 the crown of the unerupted canine had been partly absorbed owing to septic infection of the tooth follicle.

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CHAPTER III

Variations of the Teeth

Variations in Size—Variations in Number—Variations in Shape—Gemination of the Teeth—Enamel Nodules—Anomalous Teeth—Variations in the course of the Blood-vessels

(A) VARIATIONS IN SIZE

THERE is considerable variation in the general proportions of series of teeth. See fig. 34.

As a rule the teeth in a normal and complete dentition bear a definite proportional relation to one another in size. Occasionally, however, this relation is disturbed, and one or more teeth will be found to be disproportionately large or small in comparison with the remainder of the series.

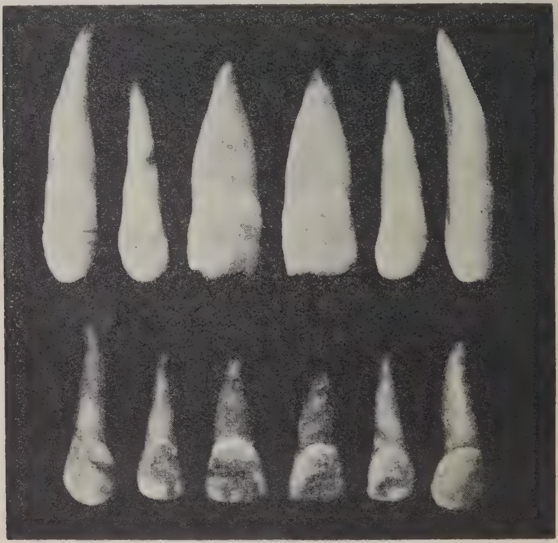

FIG. 34.

(1) Deciduous Dentition.—The maxillary canine or mandibular molar may be proportionately larger than the other teeth. Such teeth have no particular interest unless they persist, in which case it is sometimes difficult to distinguish them from the permanent teeth. If, however, care is taken in the examination of the mouth, and the history of former extractions is ascertained, no error is likely to arise. A deciduous canine can generally be distinguished from a permanent one by:—

(*a*) The abrupt termination of the enamel at its neck.
(*b*) The signs of attrition of the cutting edge.
(*c*) The size—it is smaller than the permanent tooth.
(*d*) The enamel, which is usually translucent.

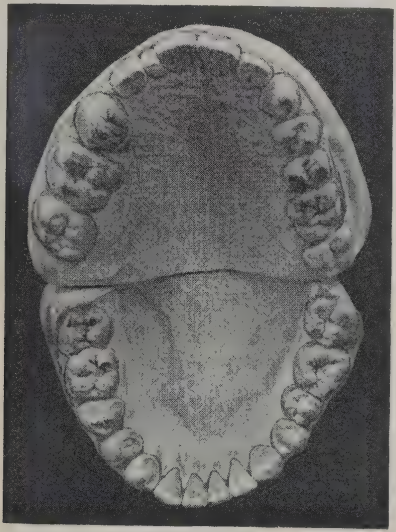

FIG. 35.—Models showing hypertrophy of teeth.

A mandibular second deciduous molar may be distinguished from a permanent one by:—

(*a*) The abrupt termination of the enamel at its neck.
(*b*) The absence of the second premolar.

(2) Permanent Dentition.—In the permanent series, the tooth which is most frequently developed to an *abnormally large* size is the maxillary first incisor. Such teeth should not be mistaken for a first incisor geminated with a supernumerary incisor. The mandibular second premolar and the mandibular second molar are, occasionally, abnormally large. *Diminution in size* occurs mostly with the second incisors. These teeth may also be modified in their shape, and, in extreme cases, are represented by simple cones. The maxillary third molar, like the second incisor, is often dwarfed and modified in shape.

Under this heading it is convenient to include those rare cases of hypertrophy of teeth seen in connection with hypertrophy of the jaws. Fig. 35 represents the model of a boy with an enlargement of the right side of the face, including the right half of the tongue. The frontal bone was involved, a distinct ridge running vertically down the centre of the forehead. In the affected maxilla the premolars had not erupted and the canine and first molar were enlarged; in the mandible the canines, premolars and molars were larger than the teeth on the left side. A similar case was also recorded by M. F. Hopson.[1]

(B) VARIATIONS IN NUMBER

The number of teeth in a complete dentition may be greater or less than the normal number. Teeth in excess of the normal number are known as supernumerary teeth; such teeth may or may not resemble normal teeth in shape. Supernumerary teeth of abnormal shape rarely have more than one root. A cone-shaped supernumerary tooth with two roots is shown in fig. 36.

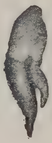

Fig. 36.—A conical-shaped supernumerary tooth with two roots. From the Museum of the Victoria Dental Hospital.

(1) Deciduous Dentition.

(*a*) Excess in Number.—Supernumerary teeth in the deciduous series generally appear in the incisor region (fig. 37). Additional teeth in the molar series are rare. The supernumerary teeth usually simulate the neighbouring teeth and may or may not be followed by supernumerary teeth in the permanent dentition. An instance of an extra maxillary second incisor preceded by geminated deciduous first and second incisors is recorded by A. Drake.[2]

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. xiii, 1920, p. 70.

[2] *Dental Record,* December, 1904, p. 555.

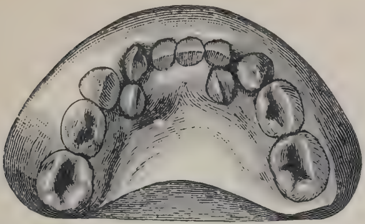

FIG. 37.—Model showing two supernumerary incisors in the mandible.

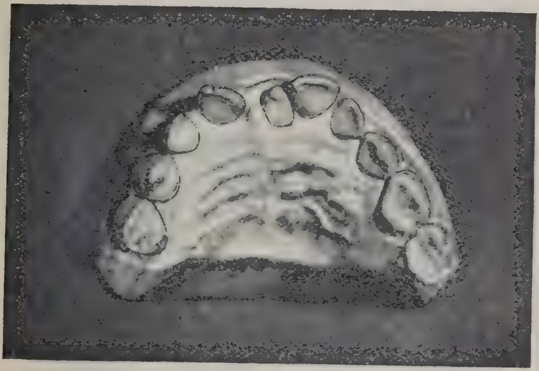

FIG. 38.—Cone-shaped supernumerary tooth situated between the deciduous maxillary first incisors.

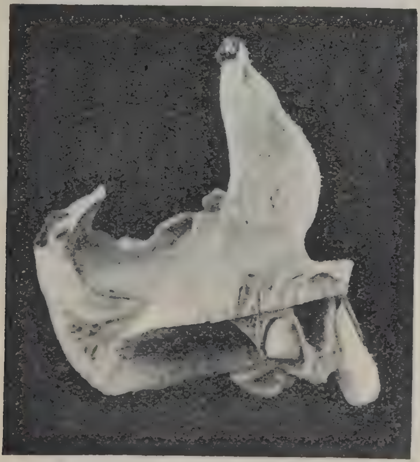

FIG. 39.[1]—Left maxilla with a cone-shaped supernumerary tooth situated behind the deciduous incisors.

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[1] For this illustration I am indebted to Messrs. C. Ash and Sons.

Excess and also deficiency in the number of the teeth are frequently transmitted variations.

An extra tooth, or even two extra teeth, conical in form, are occasionally found in the premaxilla. The teeth may be situated between the first incisors (fig. 38), or may be placed posterior to the teeth, see fig. 39[1], which shows the tooth situated immediately behind the crypt of the developing permanent incisor and with the crown directed upwards, a condition which is not uncommon. A similar condition existed in the right premaxilla.

(*b*) Deficiency in Number.—This is not so common as an excess in number. The missing tooth is usually the second incisor, but all incisors may be absent. A model of a maxilla with the right second incisor missing is shown in fig. 40. The maxillary second deciduous molars are at times absent. The absence of a tooth cannot be definitely determined except by means of radiography.

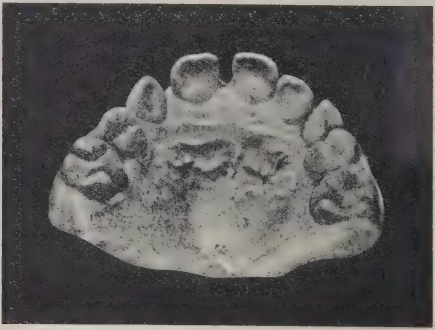

Fig. 40.—Model showing absence of the maxillary right second incisor.

(2) Permanent Dentition

(*a*) Excess in Number.

(1) Incisor Region.—Extra teeth are more common in the maxilla than in the mandible. In the **maxilla** they may be normal or abnormal in shape. When **normal in shape** they resemble the second incisors, but they are generally either larger or smaller than those teeth. The condition is at times symmetrical (fig. 41). The extra tooth may be geminated with the second incisor. In the case shown in fig. 42 (a child) the crowns were separate but the roots fused; a cone-shaped tooth was also present embedded in the bone with the crown pointing upwards. The mother and two aunts each had an extra incisor in the left maxilla.

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[1] From a specimen in the Hunter Collection, Royal College of Surgeons, England, Odonto. Series H, 57.

In the model shown in fig. 43 a supernumerary incisor is present, and there is a tendency for the first incisor to divide into two teeth.

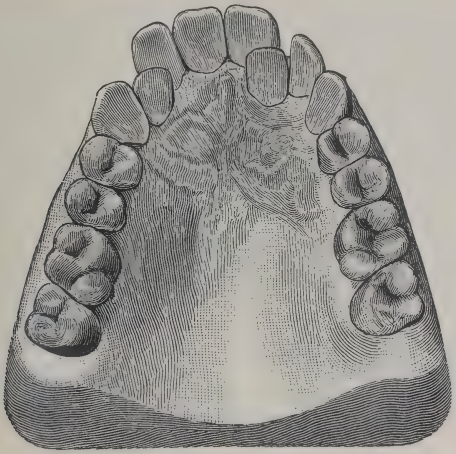

FIG. 41.—Model showing two supernumerary incisors.

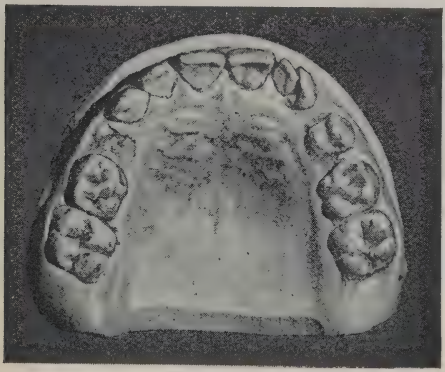

FIG. 42.

The extra tooth may be **cone-shaped**; when this is the case it is usually situated to the mesial side of the first incisor, but it may be present between the first and second incisors, or between the second incisor and the canine. In fig. 44 the tooth is in an inverted position in the bone.

The extra teeth may be **tuberculated** in form. These teeth usually appear on either side of the median line immediately posterior to the first incisors, which may be displaced. They are frequently symmetrical, give rise to a well-defined variety of

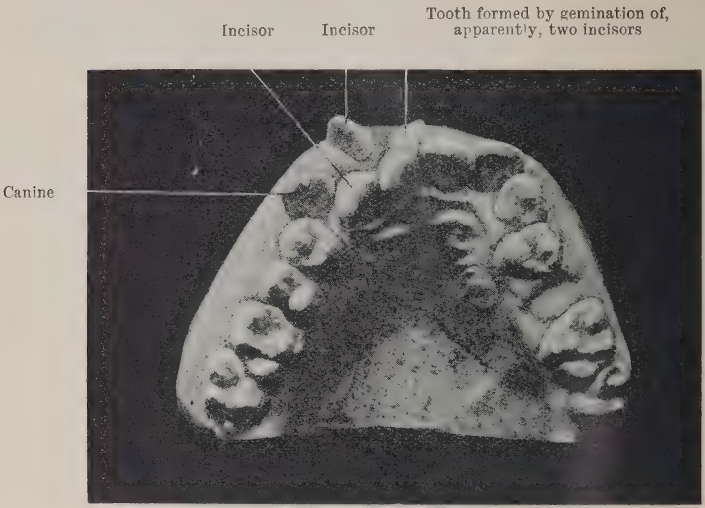

FIG. 43.—Model A supernumerary incisor is present and the first incisor is tending to divide into two teeth.

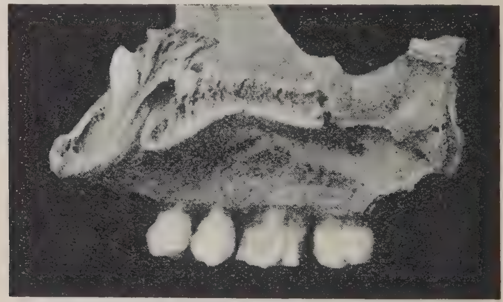

FIG. 44.—Right maxilla with a cone-shaped supernumerary tooth in an inverted position.

irregularity (fig. 45), and invariably erupt before the normal teeth. Two extra teeth of tubercular shape may be present in one premaxilla, but this is rare. A tubercular-shaped tooth may be present in one premaxilla with a normal-shaped supernumerary tooth in both premaxillæ. In a specimen in the Royal College of Surgeons[1] the maxillary right first incisor has been replaced by two small tuberculate teeth. There is a model in the same collection[2] with nine teeth in the incisor region. The first incisors are well-formed, the remaining teeth are cone-shaped and vary in size.

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[1] Odonto. Series C. 18.36.

[2] Odonto. Series C. 21.1.

An extra incisor is often associated with cases of cleft palate.—The usual arrangement of the teeth in cleft palate cases is, starting from the median line, first incisor, cleft, badly formed tooth, canine. The badly formed tooth is always situated in front of the canine, and has been termed the "pre-canine." It is the representative of an incisor. When an extra incisor is present, it is situated on the mesial side of the cleft (see figs. 46 to 48) and is often well formed.

The relation of the "pre-canine" to the suture is shown in the radiogram reproduced in fig. 49.

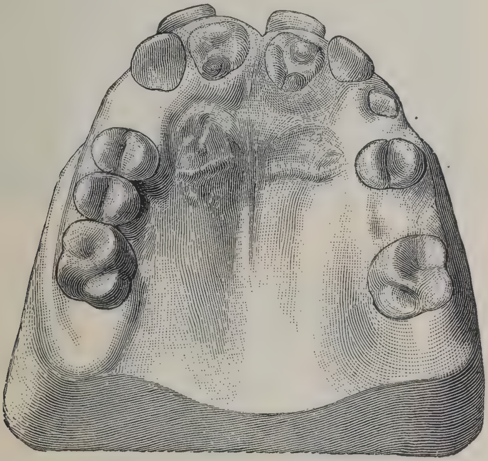

FIG. 45.—Two tuberculated supernumerary teeth immediately posterior to the first incisors.

When supernumerary teeth appear in the mandible they always simulate an incisor of normal shape.

(2) Canine Region.—There is no authentic record of a supernumerary canine. The mandibular canine may be replaced by cone-shaped teeth as shown in fig. 50.

(3) Premolar Region.—Extra premolars are met with in the mandible and in the maxilla, an extra tooth often appearing on both sides. In a remarkable case (fig. 51) which occurred in the practice of C. Handley, there were no less than six premolar teeth on one side, in addition to two other supernumerary teeth. Blair[1] gives an illustration of a case of an unusual number of teeth in the right maxilla of a boy fifteen years of age. It is a little difficult to determine the nature of the teeth from the illustration, but they appear to be four premolars and four deciduous molars. A model showing five mandibular premolars on one side was exhibited by

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[1] "Surgery and Diseases of the Mouth and Jaws," Third Edition, p. 434.

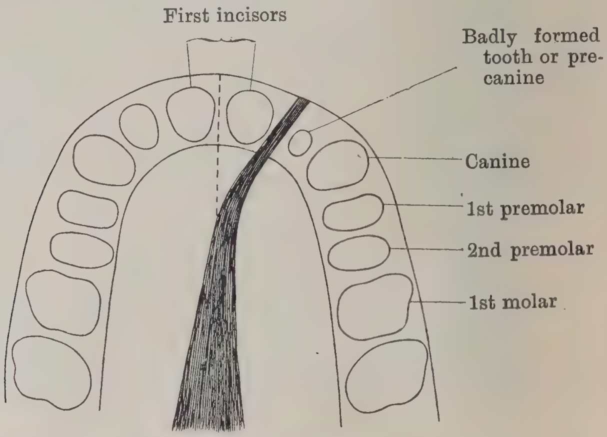

FIG. 46.—Usual arrangement.

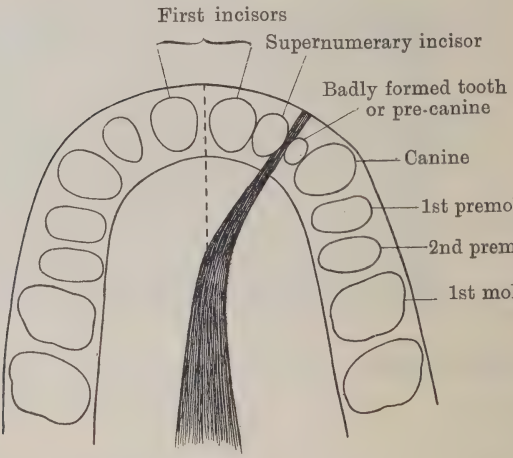

FIG. 47.—Unusual arrangement.

P. Linnell at the annual meeting of the British Dental Association, held in Manchester in 1892.

The additional premolar may be represented by two denticles (fig. 52).

(4) Molar Region.—Supernumerary teeth in the molar region

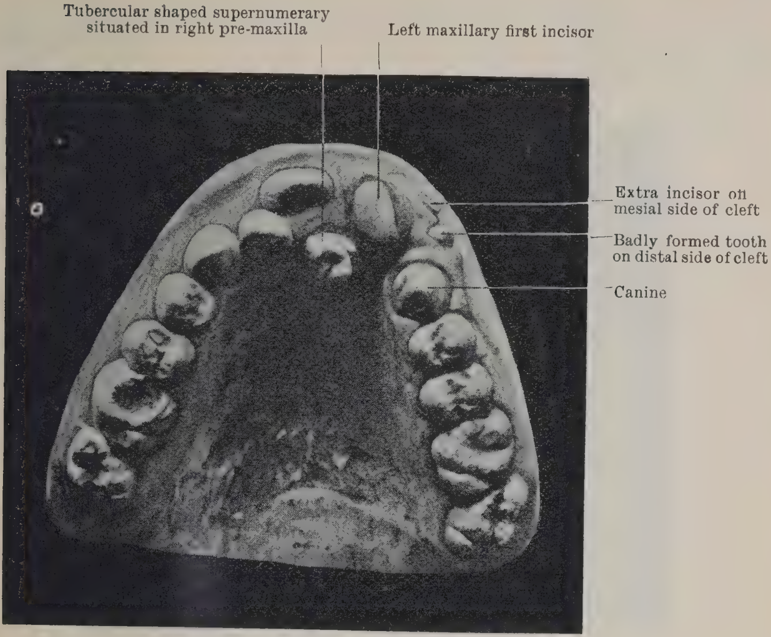
Tubercular shaped supernumerary situated in right pre-maxilla
Left maxillary first incisor
Extra incisor on mesial side of cleft
Badly formed tooth on distal side of cleft
Canine

Fig. 48.

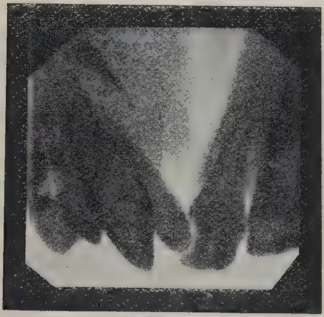

Fig. 49.

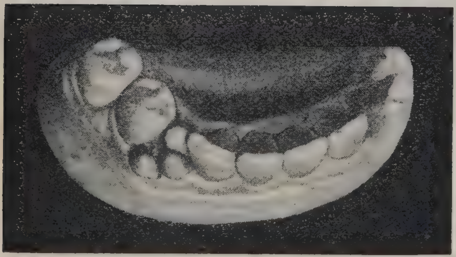

Fig. 50.—Mandibular canine replaced by three cone-shaped teeth.

are more common in the maxilla than in the mandible. The extra teeth may be placed behind the third molar or may appear on the labial side either between the first and second, or between the second and third molars. The extra tooth is usually diminutive in size, and in such cases it is by no means uncommon to find that the third molar is also dwarfed in character. Two extra teeth may be present, both situated on the buccal aspect of the molars. A

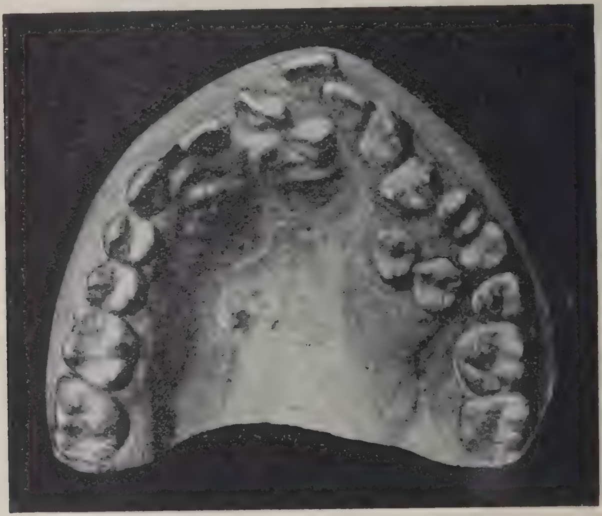

Fig. 51.

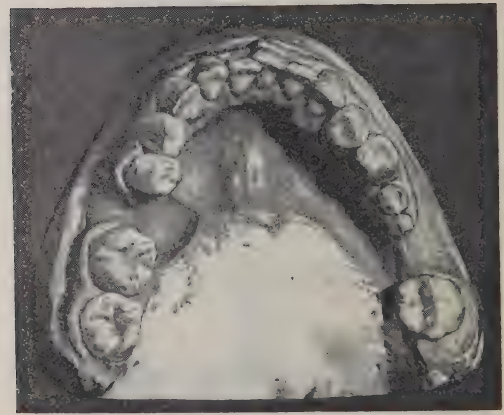

Fig. 52.—Model showing two small teeth immediately posterior to the mandibular left second premolar.

case has been seen in which the first tooth was situated near the antero-external angle and the second tooth near the postero-external angle of the third molar. In one case recorded[1] there were two extra teeth in the mandible of a male; the third molar had not erupted; one extra molar was situated above, and the other posterior to the tooth.

Bolk[2] considers that supernumerary teeth in this region are not identical in origin. To those placed labially he gives the term "para-molar," the one between the first and second molars being named anterior para-molar, the one between the second and third molars posterior para-molar; to those situated behind the third molar "disto-molar." Two para-molars may be present on one side or a para-molar in addition to a disto-molar. The para-molars may be fused with the second or third molars, forming the "para-molar" tubercle; the fusion is always with the anterior buccal cusp and never occurs in connection with the first molar. The posterior para-molar is more common than the anterior; but the para-molar tubercle is more often met with in connection with the second than the third molar. The case shown in fig. 53, copied from the *Dental Cosmos*, would seem to form a connecting link between the para-molar and the para-molar tubercle.

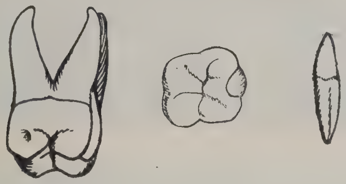

FIG. 53.

When the "disto-molar" is fused with the third molar the fusion, in the opinion of Bolk, always takes place with the postero-internal cusp of the third molar. In the mandible the para-molar tubercle is rare, but, when present, it usually has a separate root; the tubercle is often absent, but the para-molar root is frequently present. In the maxilla the para-molar tubercle seldom has a separate root.

A remarkable case of supernumerary teeth has been recorded by J. H. Gibbs.[3] In a child aged two years and nine months a swelling occurred on the right side of the mandible. All the deciduous teeth were fully erupted, and, projecting through the gum below the level of the deciduous canine, was a tooth composed of the geminated crowns of a deciduous second incisor and canine. The swelling was opened and six teeth were removed. These teeth

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[1] *Dental Cosmos*, August, 1919.

[2] Supernumerary Teeth in the molar region in man, *Brit. Dent. Journ.*, February 2, 1914, p. 121.

[3] *Trans. Int. Med. Cong.* (Stomatological Section), 1913.

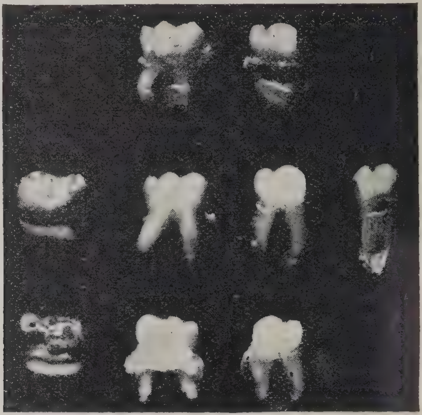

FIG. 54.—*Top row*—in use; *middle row*—geminated second incisor and canine, two deciduous molars and permanent molar; *bottom row*—two deciduous molars and permanent molar morphologically belonging to left side. (From *Proc. 17th Int. Med. Congress*, Stomatological Section.)

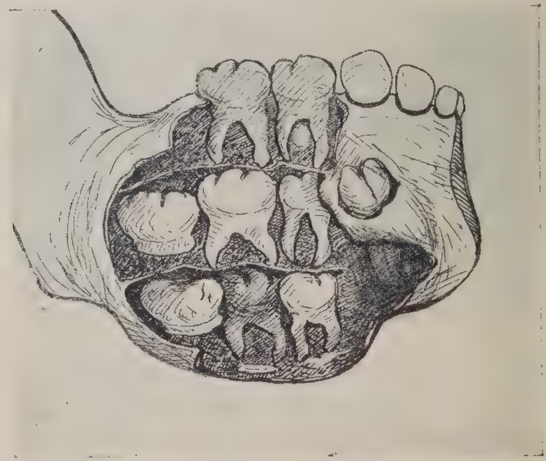

FIG. 55.—Drawing of the tumour made after the operation to show the relative position of the parts. From *Proc. 17th Int. Med. Congress*, Stomatological Section.)

proved to be four deciduous molars and two permanent molars, and it was found on examination that three of them—two deciduous molars and one permanent molar—belonged morphologically to the left side. The teeth removed from the tumour are shown in fig. 54. Unfortunately a radiogram of the case was not taken before operation. The drawing, fig. 55, shows the relative position of the parts.

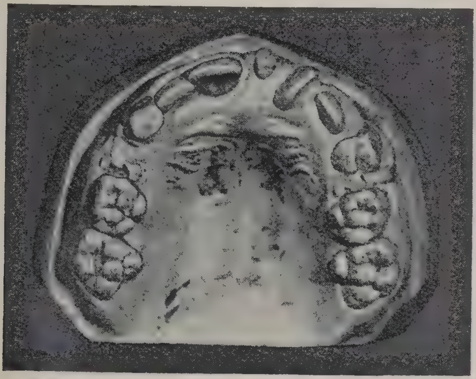

FIG. 56.

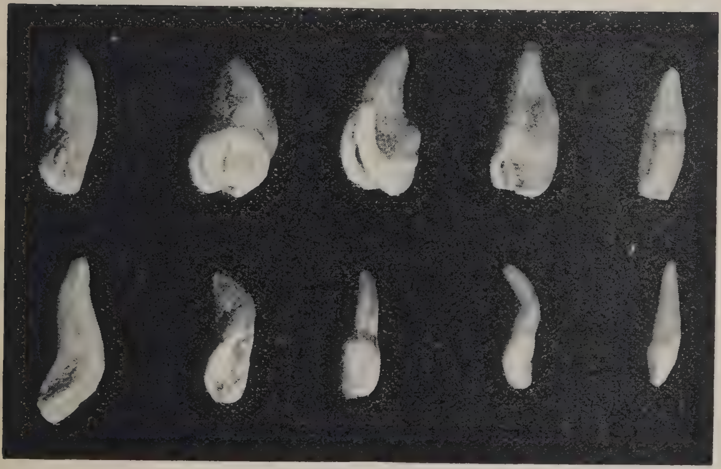

FIG. 57.—Varieties of supernumerary teeth.

It is probable that this case was of a teratomatous nature and an example of re-duplication of the alveolar portion of the mandible. It is possible that the cases recorded by Blair and Handley were of a similar nature.

Supernumerary teeth are often associated with a tendency to extra tooth formation as evidenced by the presence of extra cusps. For example, the cone-shaped tooth in fig. 56 was associated with additional cusps on the second deciduous and first permanent molars. In some cases the extra cusp formation is confined to the side on which the extra tooth is situated.

Varieties of abnormal-shaped supernumerary teeth are shown in fig. 57.

Treatment.—Supernumerary teeth frequently appear before the permanent teeth. They should be removed as soon as they are recognized, but if their presence has been overlooked and the teeth are in a crowded condition it may be advisable, under certain conditions, to retain them (see also p. 35).

(*b*) DEFICIENCY IN NUMBER.—Any number of teeth may be missing, that is to say, the deficiency may be limited to a single tooth or may extend to the whole series, but the commonest condition is that in which the deficiency is limited to one or two teeth.

The maxillary second incisors are, perhaps, most frequently missing; after these, the mandibular second premolars, the maxillary third molars and the second premolars. When the maxillary third molars appear to be missing, care must be taken to ascertain that the teeth supposed to be the first and second molars are not in reality the second and third molars, the first having been lost at an early age.

The absence of a maxillary second incisor on one side is often associated with mal-development of the corresponding tooth on the other side. Absence of the second incisors is met with in skulls of semi-civilized and barbaric races, and Wright[1] records such a case in the skull of a neolithic man. R. Clement Lucas[2] states that hare-lip and cleft palate in the child are often associated with the absence of the second incisors or with an ill-developed incisor in one of the parents.

With regard to the absence of a premolar the possibility must be considered of the tooth germ having been destroyed by sepsis or removed during the extraction of the deciduous molar.

The absence of the third molars would appear to be more common in highly civilized communities than in primitive races. Absence of one or both mandibular first incisors is a rare condition and is occasionally associated with absence of the maxillary second incisors. In a case under the care of H. Stobie, the maxillary second and mandibular first incisors were absent in addition to the second premolars.

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[1] *Proc. Roy. Soc. Med.*, vol. ii (Odonto. Sec.), p. 3.

[2] *British Journal of Children's Diseaes*, November 19, 1904.

Absence of a permanent canine from the series is rare. A case was recorded[1] in which the maxillary left tooth was absent, the deciduous tooth being present. The absence of the tooth was determined by radiography.

Persistence of the deciduous canine is met with in a large number of patients, mostly females. In these cases the permanent successor is usually present, but is situated in an erratic position.

The whole group of incisors, maxillary and mandibular, may be absent, occasionally the premolars, and very rarely the molars. In cases where a **large number of permanent teeth** are absent the first molars are usually present on either side in maxilla and mandible and one or two badly shaped teeth in the incisor region (fig. 58). An instance of marked deficiency of permanent teeth in twins aged sixteen years was observed by T. Clarence. Their dentitions were:—

$$\frac{76\ \ 4\mathrm{c}\ \ 1}{6\ \ \ \mathrm{dcba}}\Bigg|\frac{1\ \ \mathrm{c}45\ \ 7}{\mathrm{abc}\ \ \ \mathrm{e}} \quad \text{and} \quad \frac{76\ \ 4\mathrm{c}\ \ 1}{\mathrm{dcba}}\Bigg|\frac{1\ \ \mathrm{c}4\ \ 67}{\mathrm{abc}}$$

A very interesting case is recorded by Jarre.[2] There were no deciduous teeth until the age of fifteen months when a tooth conical in form appeared in the maxilla on the left side of the median line. Four months later a similar tooth appeared on the right side. At the age of twenty-three months a tooth erupted in the situation of the maxillary second incisor. About the third year two more teeth of the size and form of deciduous molars appeared in the maxilla on the right and left sides. No teeth appeared in the mandible. At the age of seven years the three teeth in the incisor region were replaced by three others, also conical in form. The deciduous molars were persistent at the age of twelve when the condition of the jaws was as follows: In the maxilla five teeth, three being permanent, two deciduous; in the mandible no teeth. The hair on this patient's head was scanty, the scalp being plainly seen, while the rest of the body was entirely hairless. The nails presented peculiarities. They were covered with white opaque spots and streaks which occupied the whole thickness of the tissue, this condition having been present since birth. The lenses were normal. The skin was loose and wrinkled. The fact that the nutrition of the teeth, hair and nails had been affected was interesting.

Where there is marked deficiency in the number of teeth, both sides of the jaws are usually affected, although not necessarily to the same extent. For example, a girl aged nine years had no teeth on the left side of the mandible and only the deciduous canine, second deciduous molar and first permanent molar on the left side of the maxilla, while on the right side only the first incisors in both maxilla and mandible were missing. The left side of the girl's scalp was almost totally devoid of hair.[1]

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[1] *Dental Cosmos,* May, 1922, p. 575.

[2] *Ibid.,* June, 1892, p. 468.

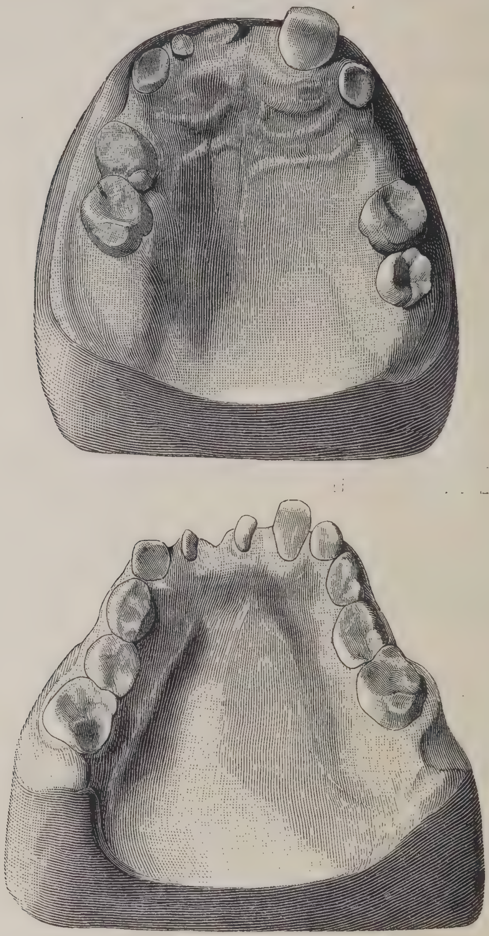

Fig. 58.—Models showing deficiency in the number of permanent teeth. The patient was a man, aged 35.

A case of **entire absence of teeth** accompanied by marked deficiency of hair is recorded by Guildford.[1] The patient, a man aged forty-eight, was nearly bald, there being only a slight covering of down. Hair was present in the pubic and axillary regions, but the surface of the body was entirely free from hair. The sudoriferous glands were absent or suppressed, for he had never perspired, and he had no sense of smell or taste. Of his six children two showed signs of inherited abnormality in having only about half the usual number of teeth.

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[1] Recorded by P. Ledger Etheridge (*Brit. Dent. Journ.*, January 15, 1913).

A case of total absence of teeth in a boy aged sixteen is recorded by W. Rushton.[2] The only other abnormality associated with the condition was in the hair, which was of a soft character resembling wool.

Total absence of teeth in two brothers has been recorded by J. H. Gibbs.[3] There was definite abnormality of the skin, nails, hair and sudoriferous glands and a history of defective tooth formation in other members of the family, the defect being transmitted through the female parent.

In a case recorded by W. Schoenlank[4] the absence of teeth was associated with epithelium showing fœtal conditions in the shortness of papillæ which passed into the underlying connective tissue.

Cases of **deficiency of teeth associated with abundance of hair** have been recorded. In the case of Andrian Jeftichfen,[5] the whole of the face, nose, forehead, cheeks, and ears was covered with long brown hair, which also extended partly down the back. His son, Fedor, at the age of three years showed the same tendency to hairiness. The father had no teeth up to seventeen years of age, and eventually only erupted four teeth in the mandible and one in the maxilla. The son Fedor, at the age of three, possessed only four incisors in the maxilla. The Burmese hairy family, consisting of grandfather, mother, and son, are said to have been deficient in the number of their teeth, but there is no reliable record.

From the foregoing cases it is evident that there is a correlation between the hair and the teeth. In one class there is deficiency of both structures; in the other, deficiency of teeth is associated with redundance of hair.

W. A. Maggs[6] has recorded a case in which **defective develop-**

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[1] *Transactions World's Columbian Dental Congress*, p. 257.

[2] *Trans. Odonto. Soc.*, vol. xxxvi, p. 17.

[3] *Dental Record*, November 1, 1915, p. 669.

[4] *Deutsche Monatsschrift für Zahnheilkunde*, January, 1921.

[5] *Brit. Journ. Dent. Sci.*, vol. xvi, p. 527.

[6] *Trans. Odonto. Soc.*, vol. xxii, p. 181.

ment of the permanent teeth was **associated with malformation of the eyes and anus.** The patient was a girl, aged eighteen. The anus, imperforate at birth, was established by operation. The maxilla was without either incisors or molars. In the mandible were ten teeth, which were badly formed. The condition of the eyes was as follows: Each eye was very deficient in size (microphthalmos); there was almost complete absence of irides, but the lenses were present, as ascertained by oblique illumination. Each eye had thirteen dioptres of myopia, and could not be improved by spherical glasses. The ophthalmoscope showed the discs to be small. There was no coloboma of choroid, but a few patches of opaque nerve fibres were seen in the retina. Vision was defective in each eye. There was nothing suggestive of specific disease. The hair and nails were normal.

Treatment.—Absence of the maxillary second incisors should be suspected if these teeth have not erupted at the age of ten years. The treatment will depend upon the conditions present. In the majority of cases the deciduous second incisors and canines should be extracted in order to allow the permanent canines to erupt towards the first incisors.

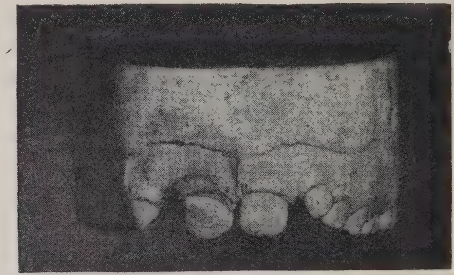

Fig. 59.—Model showing absence of the maxillary right second incisor.

If only one incisor is absent and the fellow tooth is diminutive the latter should be removed in order to obtain a symmetrical arrangement of the teeth. In the case fig. 59 the right tooth was absent, with a fair interval between the first incisor and the deciduous canine. The radiogram showed that the permanent canine was erupting towards the incisor. Under such conditions if there is sufficient space for the permanent canine to erupt without causing absorption of the root of the deciduous canine the latter may be allowed to remain; but should the deciduous canine show signs of absorption, its early removal is called for, in order to allow the premolars to move forward.

(C) VARIATIONS IN SHAPE

(1) Deciduous Dentition

Cases of pronounced cusps arising from the cervico-marginal ridge of the incisors and canines are met with. Additional cusps may be present at the antero-internal aspect of the maxillary second molar and the antero-external aspect of the first molar.

An interesting variation of the maxillary first incisors has been observed and described by A. T. Pitts.[1] The roots, as shown in fig. 60, are bent forward on themselves and are grooved longitudinally, the groove being more marked on the labial surface, and the extremities are bifurcated.

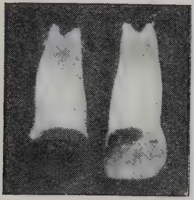

Fig. 60.—Maxillary deciduous first incisors, showing bifurcation of the roots, which are bent forward. (From *Proc. Roy Soc. Med.*).

The maxillary canines may be peg-shaped and the mandibular teeth may be deeply grooved on the labial surfaces. Occasionally the root of the mandibular canine is bifid. The maxillary second molar may have four roots and the mandibular three. The roots of the mandibular first molar may be fused together.

(2) Permanent Dentition

(*a*) Maxillary Teeth

(i) *First Incisor.*—The following are some of the variations in shape met with:—

(*a*) A considerable flattening from before backwards (fig. 61).

(*b*) The crown altered so as to resemble a simple cone (fig. 62).

(*c*) Disproportion between the width of the crown and the root (fig. 63, *a*).

(*d*) Disproportion between the length of the crown and the root (fig. 63, *b*).

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. v, p. 41.

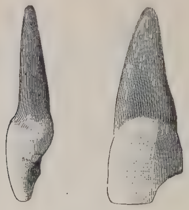


FIG. 61.

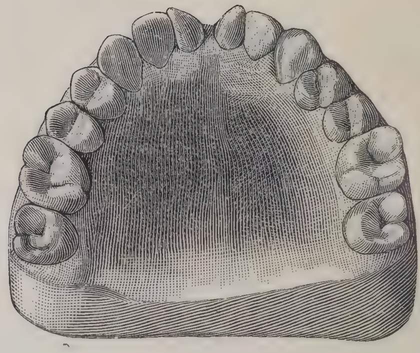


FIG. 62.

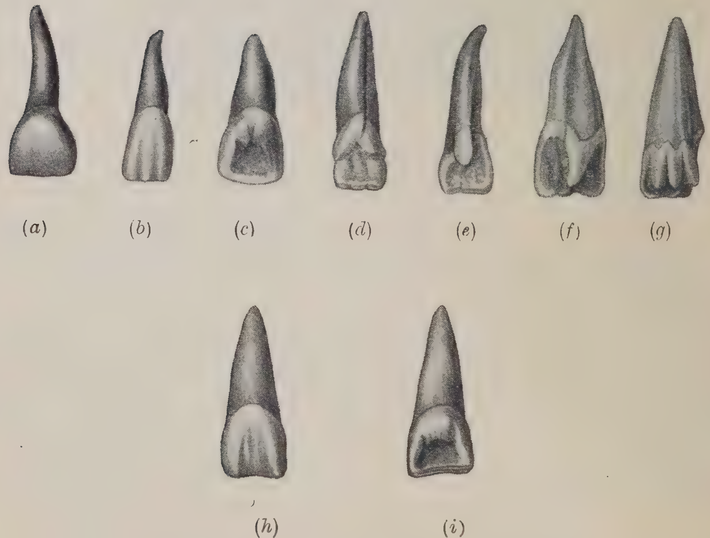


FIG. 63.—Maxillary first incisors showing variations in shape.

(*e*) Groove running from the posterior cervico-marginal ridge on to the root (fig. 63, *d*).

(*f*) Marked development of the posterior cervico-marginal ridge (fig. 63, *c*).

(*g*) Development of a cusp from the posterior cervico-marginal ridge, the cusp diminishing in size towards the cutting edge (fig. 63, *e*). The formation of the cusp may be associated with a bend in the labial surface of the tooth (fig. 63, *f*).

(*h*) Development of three cusps from the cervico-marginal ridge associated with marked bending of the labial surface (fig. 63, *g*).

(*i*) A thickening of the mesial and labial margins of the anterior and posterior surfaces (figs. 63, *h* and 63, *i*).

(*j*) An extra root (fig. 64).

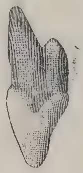
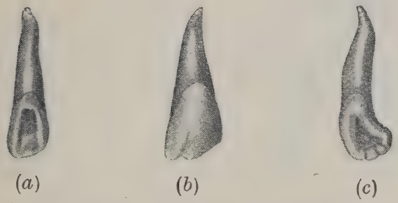


FIG. 64.



(*a*) (*b*) (*c*)

FIG. 65.—Maxillary second incisors showing variations in shape.

(ii) *Second Incisor.*

(*a*) Variation in shape of the crown, the mesial and distal angles being so rounded as to cause the tooth to resemble a canine.

(*b*) The crown so altered as to appear as a simple cone.

(*c*) Pronounced lingual fossa due to development of the posterior cervico-marginal ridge (fig. 65, *a*).

(*d*) A groove running down the mesial aspect of the root.

(*e*) Development of a cusp from the posterior cervico-marginal ridge, accompanied in some instances by a groove running down the root.

(*f*) A notch on the cutting edge towards the mesial angle (fig. 65, *b*).

(*g*) Depression in the mesial aspect near the neck (fig. 65, *c*).

(*h*) An extra root.

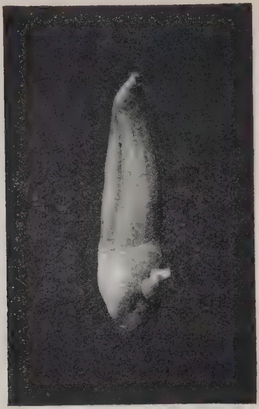


FIG. 66.

Hunter collection, Royal College of Surgeons, Odonto series H. 105.

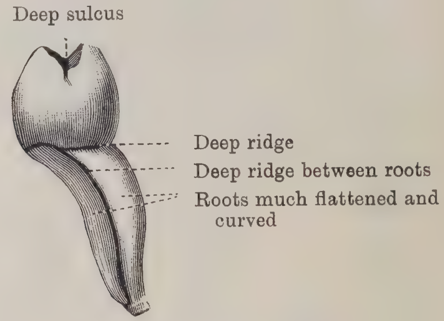


FIG. 67.[1]—Side view of tooth.

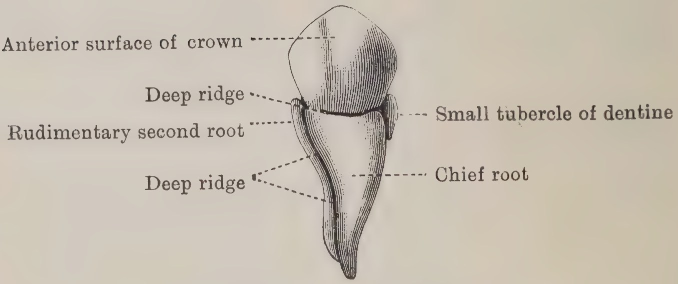


FIG. 68.[1]—Anterior view of tooth.

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[1] From *Journ. Brit. Dent. Assoc.*

(iii) *Canine.*

(*a*) The root may be grooved, and bifurcation of the apex may take place. (The latter is very rare.)

(*b*) Development of a cusp from the posterior cervico-marginal ridge. This irregularity may be so marked as to cause the tooth to resemble a premolar.

(*c*) The cutting edge may be divided into two unequal cusps by a notch.

(*d*) A spike-like projection from the labial surface (fig. 66).

(iv) *Premolars.*—**The first premolar** is very irregular in regard to the form and number of its roots. Externally the root nearly always shows signs of bifurcation, and in some cases possesses two or three well-defined roots. When there are three roots they are arranged on the same plan as in the maxillary molar.

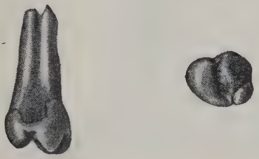

Fig. 69.—Maxillary premolar with an additional cusp.

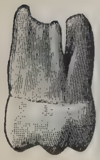

Fig. 70.—Maxillary first molar, the posterior buccal and palatine roots being united by cement.

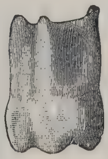

Fig. 71.—Maxillary first molar, showing all three roots united by cement.

Three-rooted maxillary first premolars may be associated with a marked tendency to two roots on the corresponding mandibular teeth.

A curious first premolar is shown in figs. 67[1] and 68[1].

The second premolar is more constant in form than the first premolar. Two or three roots may be present. An extra cusp occasionally appears on the premolars (fig. 69).

(v) *Molars.*—**The first molar** may have a fourth root. The fourth root is always situated between the anterior buccal and the palatine roots. A fifth root is occasionally seen. The roots may be fused together, a union of the posterior buccal and palatine being most common (fig. 70). At times all three roots may be fused together (fig. 71). H. P. Pickerill[1] has recorded an interesting

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[1] Described by J. F. Rymer, *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 162.

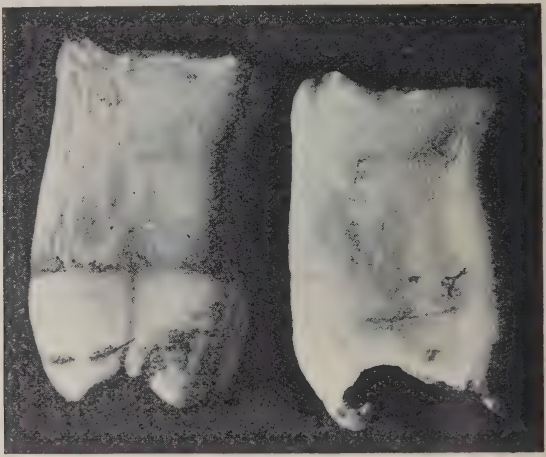

FIG. 72. × 2½.
From *Proc. Roy. Soc. Med.*

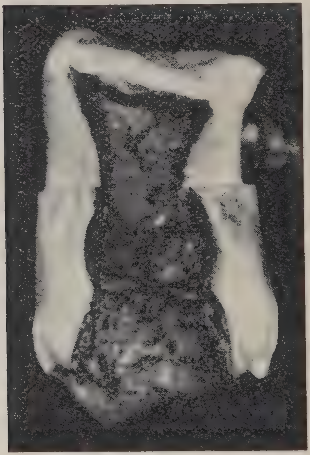

FIG. 73. × 2½.
From *Proc. Roy. Soc. Med.*

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. ii, p. 150.

variation of the maxillary first molars (fig. 72). The crowns were large but normal in shape; the apices, instead of being conical, presented a large, uneven quadrilateral surface, the naked-eye appearance suggesting that four roots had spread out and had become fused, the centre being filled in with cement. A section (fig. 73) showed one large central quadrilateral pulp cavity surrounded by a circular and parallel wall of dentine.

The buccal roots of the maxillary molars are often curved, and may approximate at their apices so as to embrace the septum. An extra cusp is often seen on the mesio-lingual aspect.

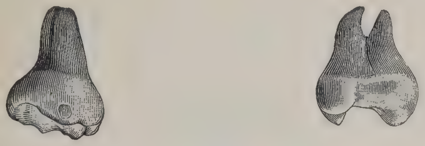

FIG. 74.—Abnormally shaped maxillary second molars.

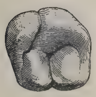

FIG. 75.—Normal left maxillary first molar.

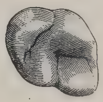

FIG. 76.—Oblique-rooted left maxillary first molar.

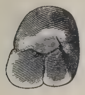

FIG. 77.—Normal right maxillary second molar.

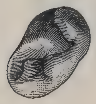

FIG. 78.—Oblique-rooted right maxillary second molar.

The second molar may present abnormalities similar to the first. A peculiar flattening of the tooth, as shown in fig. 74, is met with.

The third molar assumes a great variety of shapes. The roots may be all fused together, and in one specimen in the Museum of the Royal College of Surgeons the apex is cup-shaped with numerous holes for the vessels of the pulp to enter. The roots may be increased in number, and flexions are often present.

The normal position of the roots of the molars may be altered by the posterior buccal root being displaced inwards and forwards. This variation is termed "oblique rooted," and attention was first drawn to it by Booth Pearsall[1] (see figs. 75 to 78).

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[1] *Journn. Brit. Dent. Assoc.*, vol. x, p. 38.

(*b*) Mandibular Teeth

(i) *Incisors.*

(*a*) The crown may be altered so as to resemble a single cone.

(*b*) A notch may be present on the cutting edge (fig. 79, *a*).

(*c*) A thickening may occur on the labial aspect in the median line (fig. 79, *b*).

(*d*) An extra root may arise from the lingual surface.

(ii) *Canine.*—This tooth may have an extra root. Various specimens of this abnormality are shown in fig. 80.

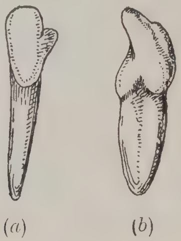
(*a*) (*b*)

Fig. 79.

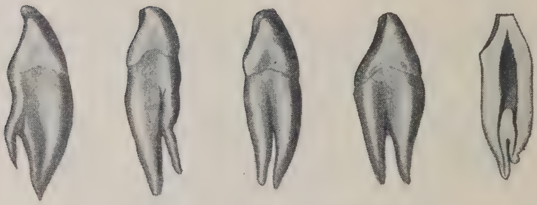
Fig. 80.—Two-rooted mandibular canines.

(iii) *Premolars.*—**The first premolar** may have two roots. " When a lower premolar tends to have two roots they are peculiarly formed, the flattened apex being bent round so as to form an approach to a second (anterior) root, and this may go on to complete division," fig. 81 (Tomes). The inner cusp of this tooth is at times feebly developed and the tooth simulates a canine.

The second premolar is more constant than the first. A curious abnormality of this tooth, which is fairly common, is shown in fig. 82; the condition is usually symmetrical.

(iv) *Molars.*—**The first molar** may have an extra root on the lingual aspect, situated either between the normal roots, or further back when it displaces the posterior root outwards (fig. 83). An extra root on the buccal side of the tooth is rare (fig. 84).

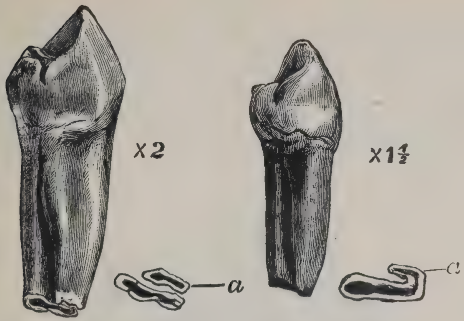

FIG. 81.[1]—Two mandibular premolars, the roots of which show two stages towards complete division. *a*, Anterior root.

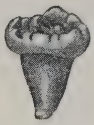

FIG. 82.—Abnormal mandibular second premolar.

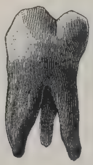

FIG. 83.—Mandibular first molar with three roots.

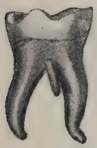

FIG. 84.—Mandibular first molar with an extra root on the buccal aspect.

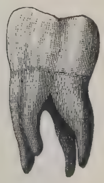

FIG. 85.—Four-rooted mandibular first molar.

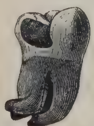

FIG. 86.

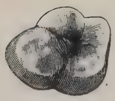

FIG. 87.

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[1] From Tomes' "Dental Anatomy."

Four roots are met with, two being anterior and two posterior (fig. 85). Occasionally the roots are found to be fused together, and the normal backward curve much exaggerated. Cases of five and six roots, which have been recorded, are probably examples of gemination. Extra cusps are met with on the buccal surface.

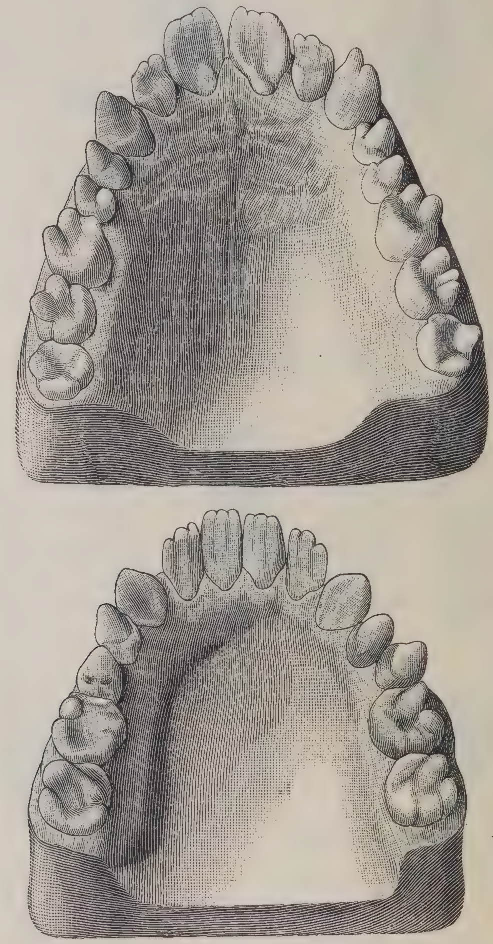

Fig. 88.

The second molar presents abnormalities similar to those found in the first molar; but fusion of the roots is more common in the second molar than in the first.

The third molar presents an increased number of cusps; the whole tooth may be reduced to a comparatively small size; the roots are often fused together and curved well backwards. In one variety the roots are fused together, but bifurcate towards the apices and present four small roots (fig. 86). A peculiar abnormality of the posterior external cusp is shown in fig. 87.

(3) Variations from the normal, involving many teeth.—A few cases of this character have been recorded. A case which occurred in the practice of C. Robbins[1] is shown in fig. 88. In two sisters of this patient a similar condition existed, though not so well marked, and some cousins were also stated to have exhibited the same peculiarities. The models are interesting, as they throw light upon the genesis of the cusps.

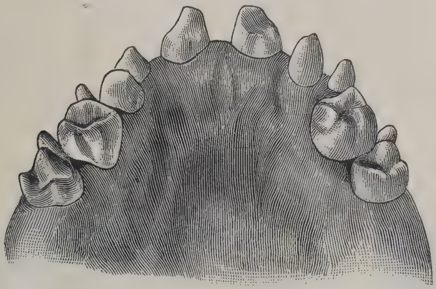

FIG. 89.

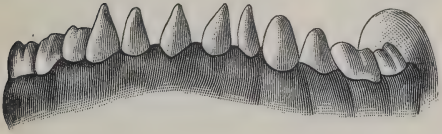

FIG. 90.

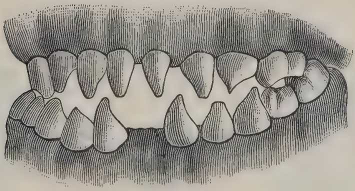

FIG. 91.

The remarkable abnormalities of teeth shown in figs. 89 to 91 were recorded[2] by H. Moon. The models were taken from the mouths of two sisters, one aged 11 (fig. 91) and the other aged 15 figs. 89 and 90). The hair of the younger sister was short, fine and scanty. Her eyes were of a grey colour, remarkably small, the sight of the left eye being defective from birth. The hair on the scalp of the elder sister was short and scanty, but her temples and cheeks were thickly covered with very fine hairs.

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[1] *Trans. Odonto. Soc.*, vol. xxiii, p. 80.

[2] *Ibid.*, vol. ix, p. 232.

(D) GEMINATION OF TEETH

"Gemination" is the term used to describe a condition in which two or more teeth are structurally united. It is more than probable that these variations are not the result of the fusion of separate tooth germs, but are the result of cleavage (dichotomy) of a tooth germ at an early stage of development.

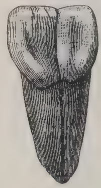


Fig. 92.

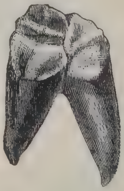
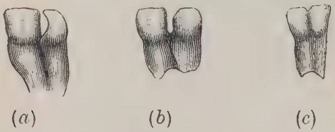


Fig. 93.

Geminated teeth may be united throughout their entire length (fig. 92), or the union may be restricted to the crowns (fig. 93), or the crowns may be separated and the roots united (see p. 44).

(1) Deciduous Dentition

Geminated teeth are more often found in the deciduous than in the permanent dentition, and occur in the mandible more frequently than in the maxilla. The condition may be symmetrical. Gemination of the second incisor and the canine is the commonest form, but gemination of the first and second incisors has also been recorded. Geminated teeth may be followed by the absence of a permanent incisor in the same region, and this would seem to indicate that only one germ was given off from the two deciduous teeth.



(a) (b) (c)

Fig. 94.

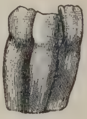


Fig. 95.

In some cases the line of fusion is well marked (fig. 94 *a* and *b*), but in others it is scarcely perceptible (fig. 94, *c*). The union is by continuity of dentine with dentine, and in some examples the pulps coalesce. An example of gemination of three deciduous teeth is shown in fig. 95.

(2) Permanent Dentition

(i) *Incisors.*—Gemination of the incisors is more common in the maxilla than in the mandible.

In the maxilla union may occur between:—

(*a*) The first incisor and an extra incisor on one side or on both sides (fig. 96).

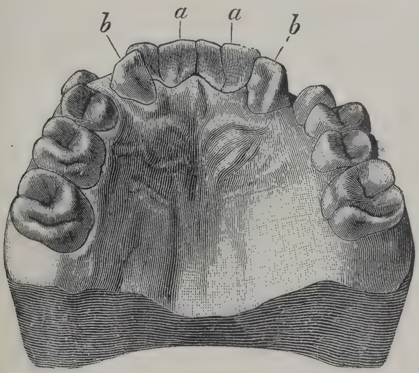


FIG. 96.—*a*, geminated first and supernumerary incisors; *b*, second incisors.

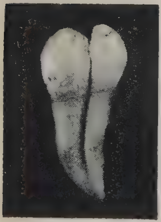


FIG. 97.

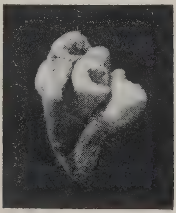


FIG. 98.

(*b*) The first and second incisors.

(*c*) The second incisor and an extra incisor (rarely).

In the mandible gemination, when it occurs, is usually between the first and second incisors; gemination between the first incisor and an extra incisor is rare.

(ii) *Premolars.*—A case of gemination between two maxillary premolars is shown in fig. 97; in fig. 98 two maxillary premolars are united to two supernumerary teeth; and in fig. 99 two mandibular premolars are seen embracing one another.

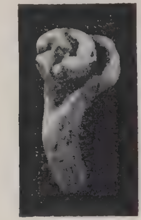


FIG. 99.

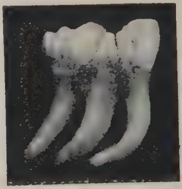


FIG. 100.

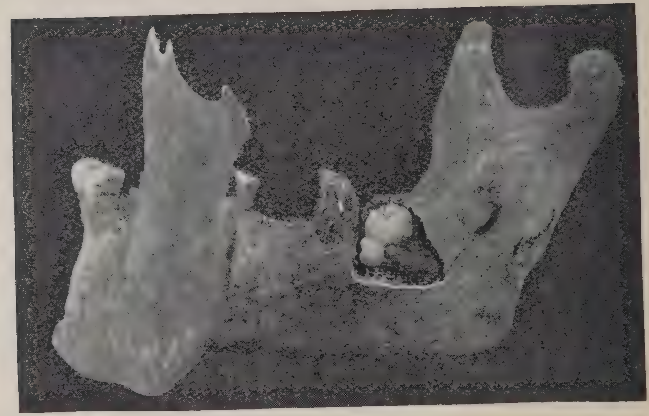


FIG. 101.

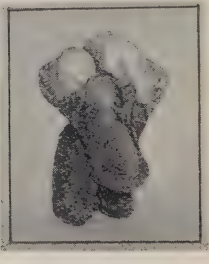


FIG. 102.

(iii) *Molars.*—Gemination in the molar region is usually between the third molars and an extra molar; union may, however, occur between the mandibular first and second molars (fig. 100). The paramolars of Bolk (see p. 51) may be fused with the second or third molars on the buccal aspects. A rare form of gemination is illustrated in fig. 101; the root of the extra tooth curls round the root of the mandibular third molar (fig. 102).

In the cases of gemination described above the condition appears to have arisen from cleavage of the tooth germ. There is, however, a condition in which the maxillary second and third molars become fused during the growth of the roots. This condition is due to the third molar developing in an irregular position, with the result that at some period of its growth it becomes fused with the roots of the second molar (fig. 103). This abnormality may be suspected if the third molar is placed high up in the tuberosity and close to the second molar.

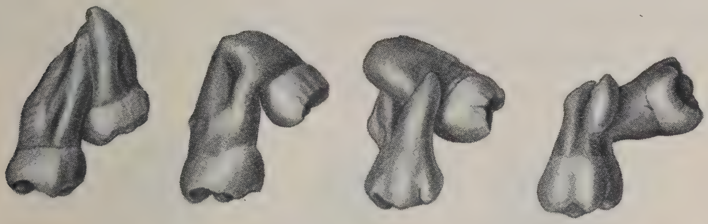


FIG. 103.

(E) ENAMEL NODULES

Enamel nodules are small excrescences on the roots of teeth and are usually situated a little below the neck and often at the

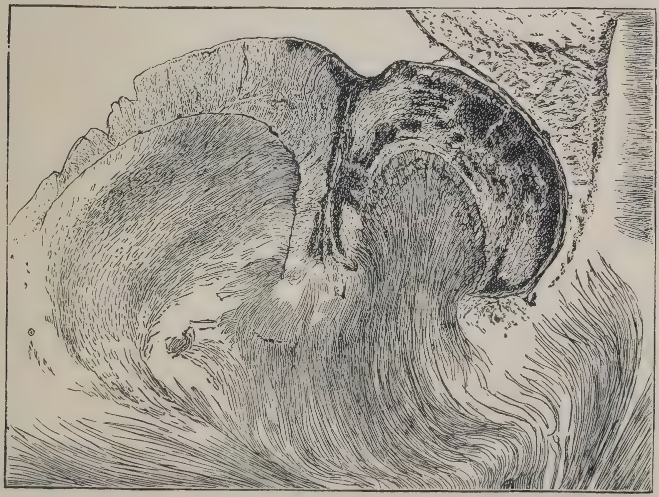


FIG. 104.—Section through an enamel nodule upon a maxillary second molar.

junction of two roots. On section, they are seen to consist of a cone of dentine covered by a fairly thick layer of enamel (fig. 104). A sharp lamina of enamel often connects the nodule with the crown of the tooth. Enamel nodules are occasionally met with on single-rooted teeth, but are mostly found on multiple-rooted teeth, chiefly on the maxillary molars between the palatine and buccal roots. When a supernumerary root is present the nodule lies between the anterior aspect of the palatine root and the supernumerary root, or if there are two nodules one is usually situated between the supernumerary and palatine roots and the other between the supernumerary and the anterior buccal roots. Examples of maxillary molars with enamel nodules are shown in figs. 105 and 106.

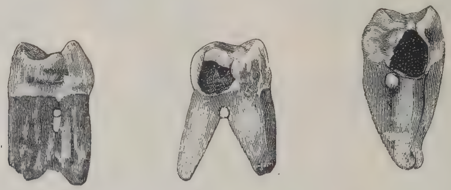


Fig 105.—Maxillary molars with enamel nodules.

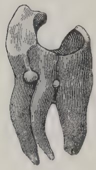


Fig. 106.—Maxillary molar with two enamel nodules.

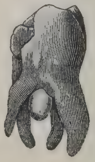


Fig. 107.—Maxillary molar showing large enamel nodule.

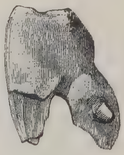


Fig. 108.

In the Museum of the Royal College of Surgeons there is a specimen of an enamel nodule on the root of a supernumerary tooth and one of a mandibular molar with a large enamel nodule which occupies the position of the posterior root.

Fig. 107 represents a maxillary molar with a very large nodule between two palatine roots, and fig. 108 a maxillary molar with a nodule at the apex of the root.

The transition from enamel nodules to supernumerary cusps or teeth and also to those prolongations of enamel which are seen between the roots of multiple teeth, especially maxillary molars (figs. 109 and 110), is probably one of degree only. Enamel nodules may be due to dichotomy of the developmental germ, that is to say, a budding from the tissues connected with the process of tooth formation; Wedl, however, does not accept this view. He says:

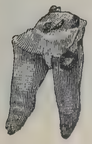


Fig. 109.—Prolongation of enamel between the roots of a mandibular molar.

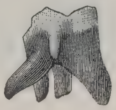


Fig. 110.—Prolongation of enamel between the roots of a maxillary molar

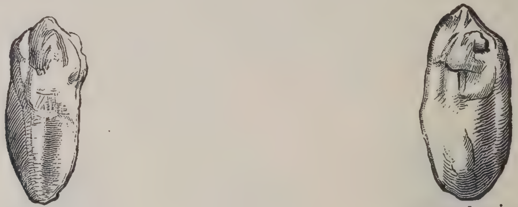
"It is obvious that the nodules or ridges which are met with upon the molars are the result of localized continuations of the development of the enamel between the already developed basal portion of the roots, and are produced by the strip of the enamel organs which has persisted longer than the rest."

(F) ANOMALOUS TEETH

Under this general heading a brief description is given of a few types of anomalous teeth which cannot at present be definitely classified. When specimens have been more thoroughly examined and more precisely classified, it may be possible to ascertain in what way they are correlated to other pathological processes of the teeth.

The editors of the Report on Odontomes issued by the British Dental Association have included these anomalous teeth among the odontomes, but this is not in keeping with the accepted views of general pathology. An odontome is grouped amongst the blastomas (ordinary tumours), that is, tumours exhibiting an independent, localized growth and arising in a body by proliferation of cells belonging to that body. The unknown stimulus which starts the growth is extrinsic in origin. On the other hand, an anomalous tooth is an inherited abnormality of development, and therefore arises from an intrinsic cause.

Incisor Region.—The maxillary first incisor may be replaced by an abnormally shaped tooth as shown in fig. 111. A section of the tooth (fig. 112) shows three distinct canals, communicating with what appear to be three distinct pulp cavities. Another irregularly shaped tooth removed from the position of the maxillary right first incisor is shown in figs. 113 and 114. The mass appears to be composed of three cone-shaped teeth fused together; the second incisor was present.



Frontal view. Lateral view.

Fig. 111.

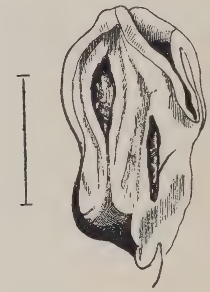


Fig. 112.

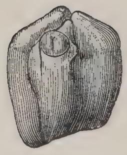


Fig. 113.[1]

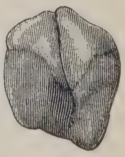


Fig. 114.[1]

A tooth of remarkable shape is shown in fig. 115. There is no history of the case, but the shape of the crown would seem to indicate that the tooth is a first incisor. The root and crown form a curve, the concavity being towards the palatal aspect. Springing from the inside of the curve, about one-third the way from the occlusal margin, is a big loop of tooth tissue. A section of the specimen shows the tissues to be arranged as shown in fig. 116. As part of the tooth has been destroyed by caries it is not possible to arrive at any satisfactory conclusion as to the cause of the abnormality.

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[1] From *Journ. Brit. Dent. Assoc.*

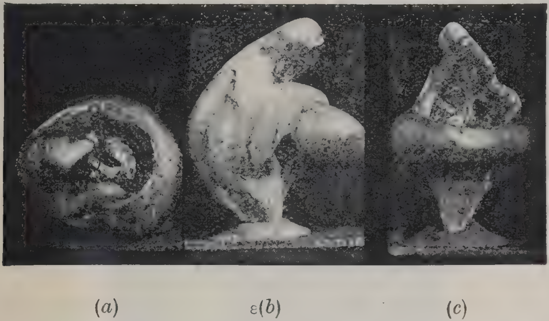

FIG. 115.[1]—*a*, view of the upper aspect; *b*, view of the lateral aspect; *c*, view of the posterior aspect.

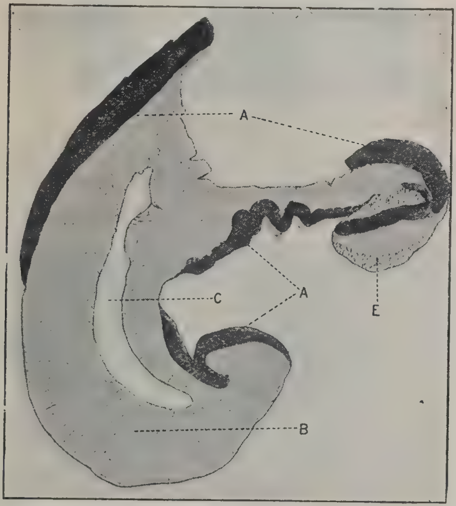

FIG. 116.[1]—A, enamel; B, dentine; C, pulp cavity; E, cement.

The specimen illustrated in fig. 117 is an example of a type of abnormal tooth found in the region of the maxillary second incisor. The crown is similar in shape to a normal second incisor, except that it has a ridge running down the middle of the lingual aspect. The root portion is bent towards the mid-line of the mouth; the superior surface is of an oval saucer shape with the margins in places bent inwards. At the junction of the root with the crown there is a piece of enamel, circular in shape, which is penetrated in the centre by a canal leading to the centre of the crown. The inferior surface is convex. A section through the specimen showed in the centre a cavity lined with enamel, with a zone of normal dentine between the base of the cavity and the enamel of the crown. The pulp cavity conformed to the shape of the root portion. A further stage in the development of this type of tooth is shown in figs. 118 and 119. The root is expanded in a cup-like manner with fragments of enamel on the inner aspect.

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[1] From *Trans. Odonto. Soc.*

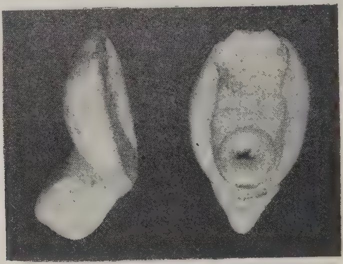


FIG. 117.

There is another type of abnormal tooth, met with in the region of the second incisor, in which the tooth is shaped as a blunt cone. A specimen is shown in fig. 120. This tooth was removed from a boy about 17 years of age. In the alveolar process there was a sinus leading to a cyst-like cavity. It will be seen on examination that the specimen is cone-shaped, the base of the cone embracing a curious nodular mass which is fused with the base of the cone at the posterior or palatal aspect. A section through the specimen is shown in fig. 121. The outer coat consists of enamel and cement; within this is dentine, and within this again and lining the large space in the centre of the tooth is enamel. Near the occlusal margin of the tooth the dentine forms a thin streak, the two layers of enamel almost touching each other at this part. In its upward extension on the labial aspect the dentine increases in thickness, and, in the upper two-thirds, surrounds a pulp chamber; whilst in the posterior or palatal wall the dentine extends upwards until, by means of a very vascular dentine, it becomes continuous with the curious circular mass of tissue embraced by the base of the cone.

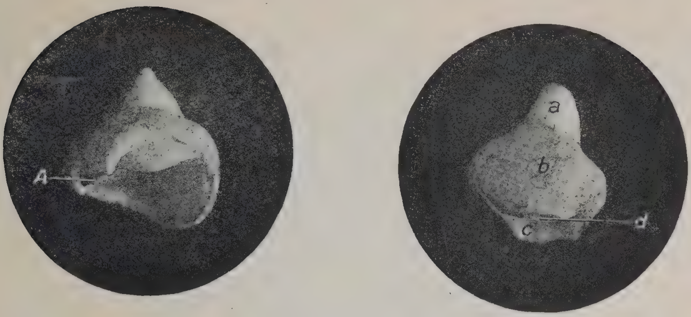


FIG. 118.[1]

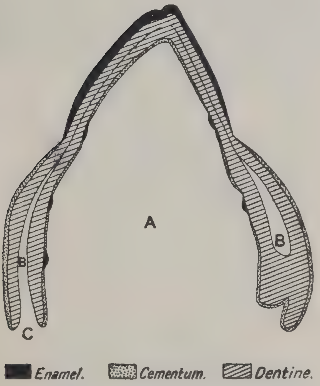
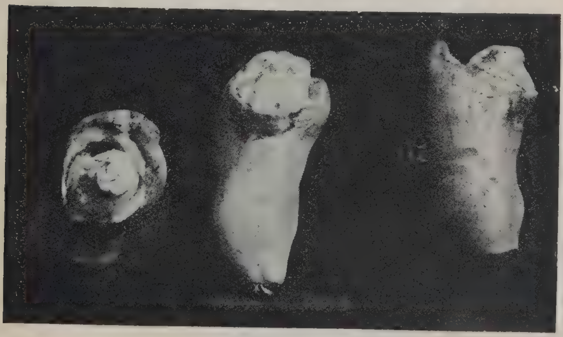


FIG. 119.[1]—A, central hollow; B, pulp cavity; C, apical slit-like foramen.



(*a*) (*b*) (*c*)

FIG. 120.[2]—*a*, view from base; *b*, view from posterior aspect; *c*, lateral view.

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[1] From *Brit. Dent. Journ.* Recorded by Graves Morris.

[2] From *Trans. Odonto. Soc.*

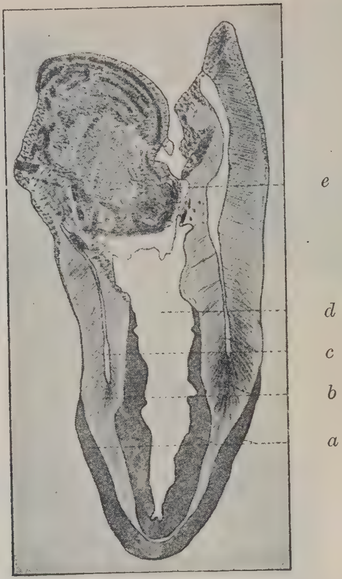

FIG. 121.[1]—*a*, enamel; *b*, dentine; *c*, pulp cavity of external tooth; *d*, cavity lined with enamel; *e*, mass of cement-like tissue.

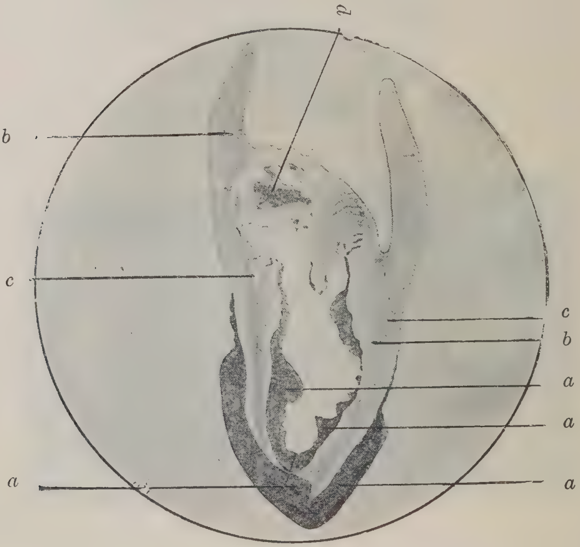

FIG. 122.[1]—*a*, enamel; *b*, dentine; *c*, pulp chamber of external tooth; *d*, mass of cemental tissue.

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[1] From *Trans. Odonto. Soc.*

This globular mass shows in section a well-marked concentric lamination, and is composed of vascular cemental tissue.

S. J. Hutchinson[1] has described a similar specimen (fig. 122)

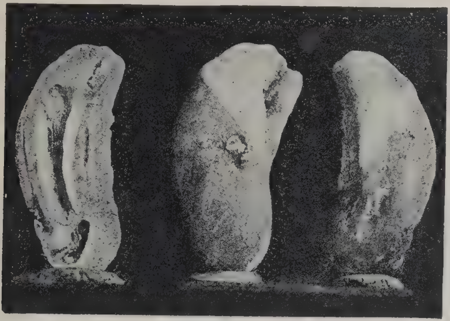

FIG. 123.[2]

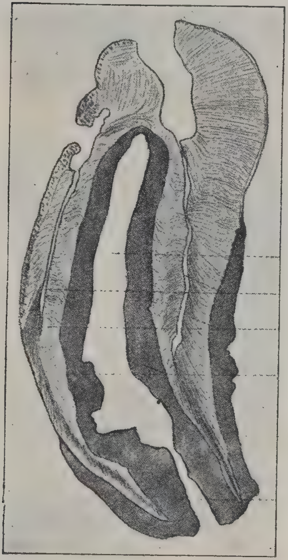

FIG. 124.[2]—*a*, enamel; *b*, space leading from exterior of tooth to cavity in the centre; *c*, dentine; *d*, pulp cavity of external tooth.

in which the abnormality has advanced a stage further than in the specimen shown in fig. 120, the dentine having almost encircled the mass of cemental-like tissue. In some of these teeth the enamel of the exterior is continuous with the enamel lining the cavity inside the tooth. This is seen in the tooth shown in figs. 123 and 124. The dentine here completely surrounds the internal layer of enamel.

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[1] *Trans. Odonto. Soc.*, vol. xi, p. 163.

[2] From *Trans. Odonto. Soc.*

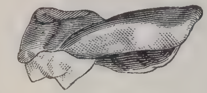


FIG. 125.[1]—Buccal view.

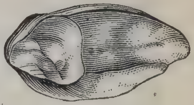


FIG. 126.[1]—Under-surface view.

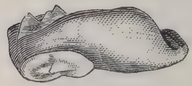


FIG. 127.[1]—Palatine view.

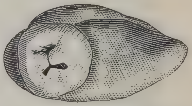


FIG. 128.[1]—Upper-surface view.

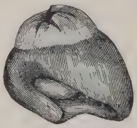


FIG. 129.[2]—This tooth was removed from the region of the mandibular second molar.

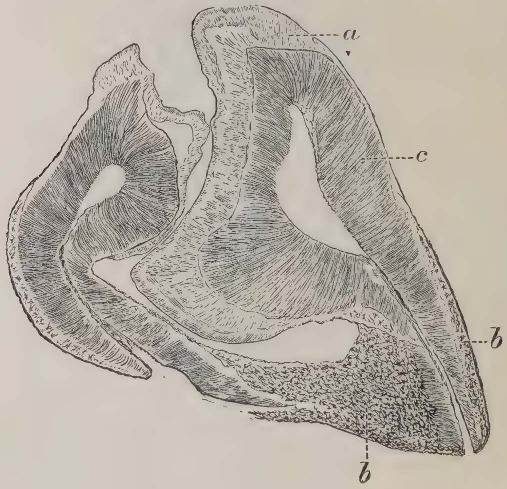


FIG. 130.[2]—Section of fig. 129—*a*, enamel; *b*, cement; *c*, dentine.

These specimens seem to form a fairly complete series. It is not clear how the enamel-lined cavity arises. It may be due to an invagination of the enamel organ of the tooth, or it may be the result of the enamel organ of one tooth being pushed, as it were, into the dentine papilla of another. The specimens (figs. 121 and 122) seem to support the latter view. In the specimen shown in fig. 121 the concentric mass was probably independent of the original aberration and may be regarded as an enlarged pulp nodule which has fused with the developing tooth.

---

[1] Described by J. E. Freeston, *Dental Cosmos*, March, 1890.

[2] From the *Journ. Brit. Dent. Assoc.*

A curious-shaped tooth removed from the region of the maxillary left canine is shown in figs. 125 to 128.

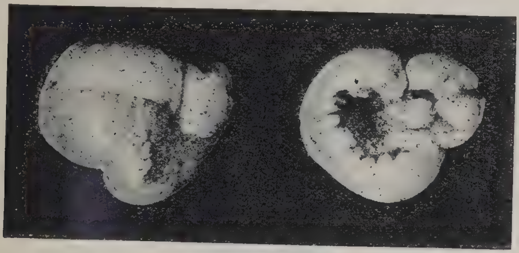


Fig. 131.

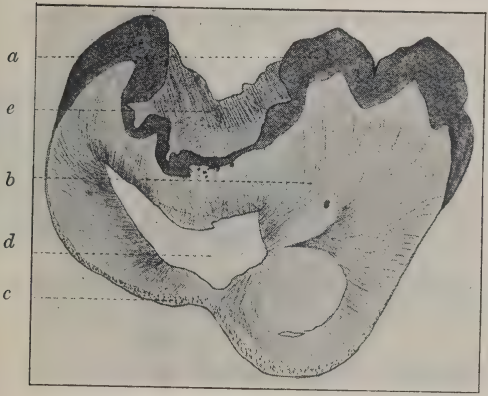


Fig. 132.—*a*, enamel; *b*, dentine; *c*, cement; *d*, pulp cavity; *e*, filling material.

Premolar Region.—The mandibular second premolar is at times replaced by an abnormally shaped tooth, as seen in fig. 82.

Molar Region.—The abnormal tooth, fig. 129, was removed from the position of the mandibular second molar. A section, fig. 130, through the specimen suggests that it is composed of two teeth geminated. The specimen illustrated in fig. 131 was removed from the region of the mandibular third molar, and the section, fig. 132, shows that it is composed of two teeth fused together with a common pulp cavity.

(G) VARIATIONS OF THE BLOOD-VESSELS

Lepkowski[1] has shown that in rare instances there are, in the embryo, anastomoses between the pulp vessels and the vessels external to the tooth germ, and it seems likely that these anastomoses may occasionally persist and give rise to the abnormality shown in fig. 133.

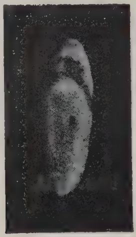
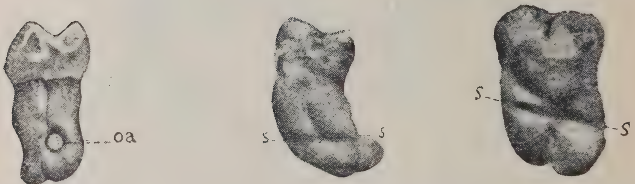


Fig. 133.



Foramen through root. Groove on buccal surface. Groove on lingual surface.

Fig. 134.[2]

The root of the third molar may be grooved, or penetrated by the mandibular vessels (fig. 134).

More rarely the vessels perforate the root of the second molar; in a case in which this occurred, the third molar root was only grooved.[3] Perforation of the root of the second premolar may occur, but it is extremely rare.

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[1] *Die Vierteilung der Gefässe in den Zähnen des Menschen* (Anatomische Hefte) H. liv.

[2] From the *Brit. Dent. Journ.*

[3] Recorded by J. B. Parfitt, *Brit. Dent. Journ.*, February 15, 1921.

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CHAPTER IV

Defective Formation of the Teeth

Defects produced by Syphilis—Hypoplastic Teeth—Hereditary Hypoplasia—Defects due to Local Causes

(A) DEFECTS PRODUCED BY GENERAL CAUSES

(1) Syphilis.—It is an established fact that congenital syphilis may produce a characteristic deformity of certain of the teeth. The manner in which syphilis affects the eruption of teeth was referred to on p. 29. In this chapter the anatomical condition of the deformity will be dealt with. The teeth affected are usually the permanent incisors, upper and lower; less frequently the first molars, and occasionally the canines.

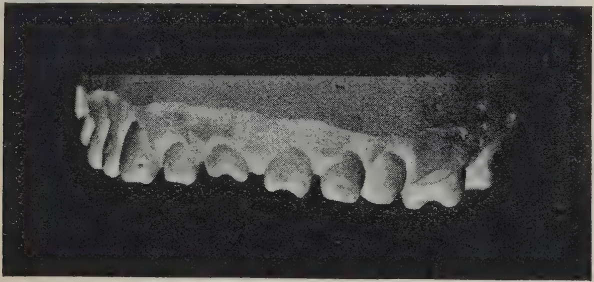

FIG. 135.[1]—Model showing syphilitic incisors.

Syphilitic incisors are small, pegtop-shaped teeth (fig. 135). The distal margins of the first incisors are generally turned outwards, and the alveolar portion of the jaw in the incisor region is imperfectly developed. The teeth are generally affected symmetrically, but exceptions occur, for example, when one incisor is perfectly formed and the other presents the typical syphilitic form.

On eruption of a healthy tooth, the cutting edge is surmounted by three little tubercles separated by two shallow notches, and, the tubercles being rapidly worn down by attrition, the cutting edge soon appears to be quite straight. In the syphilitic tooth these tubercles and notches are well marked but the central tubercle is badly developed, and the effect of attrition is to produce one central notch between the two outside tubercles. This central notch is said to give to syphilitic teeth one of their characteristic appearances, but, for reasons which will be given later on, the central notch must not be solely relied upon in diagnosis, as it also appears to be produced in teeth where there is no taint of congenital syphilis. It is said that syphilitic teeth are soft in structure and are therefore readily attacked by caries or quickly worn by mastication. Many patients, however, are seen with characteristically syphilitic teeth in which the enamel is quite normal. The second incisors are not always deformed by syphilis, the first incisors being considered by Jonathan Hutchinson as the "test" teeth. Leon Williams has found, in the case of a syphilitic tooth which he examined microscopically, that the enamel was of very faulty character and that the dentine contained interglobular spaces in abundance.

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[1] From a photograph by G. G. Campion.

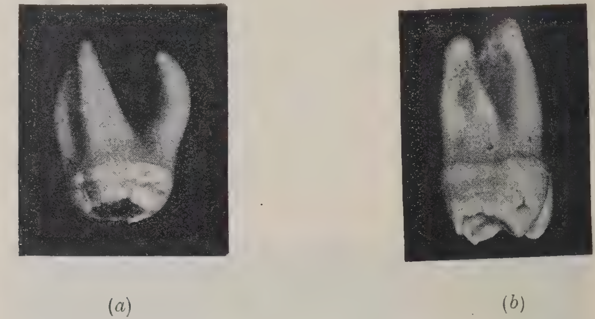

FIG. 136.[1]—The syphilitic molar (*a*) is shown in contrast with a normal-shaped molar (*b*)—both slightly enlarged. The patient from whom the syphilitic molar was removed was under the care of E. P. Collett. There was a typical history of congenital syphilis.

The deformity of syphilitic canines shows itself by a circumferential notch near the cutting edge or point of the crown Syphilitic molars, like the first incisors, are smaller than normal. They are dome-shaped, and the crown surface is of an irregular pattern, instead of having well-developed cusps (see fig. 136).

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[1] From a photograph by G. G. Campion.

The *Spironema pallidum* is to be found in the dental follicles in proximity to the vessels and their walls. Figs. 137 and 138 are from a paper by Pasini.[1]

Cavallaro, in an exhaustive paper on the Relation of Syphilis to Dentition,[2] confirms the discovery of Pasini that the *Spironema pallidum* is to be found in abundance in the dental follicle. He shows that a curious modification of the lower ends of growing teeth can often be demonstrated in the form of a constriction of the dental papilla which clinically corresponds to the atrophy of the tooth cusps so often seen. He states that at this part certain changes can be noted in the pulp tissue, the nuclei are better stained, and the infiltration of the embryonal cellular elements is more intense. He also has found in the dental follicles the following alterations—namely, endovasculitis, perivasculitis, and hæmor-

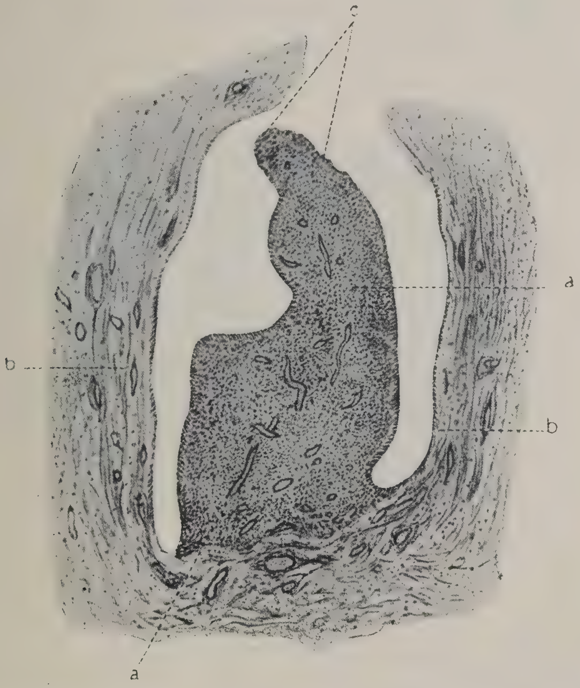

FIG. 137.—*a*, dental papilla; *b*, dental sac; *c*, free extremity of the papilla.

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[1] "Demonstration of the *Spironema pallidum* in the Dental Follicle of a Congenital Syphilitic," *La Stomatologia*, November, 1908, p. 5.

[2] *Dental Cosmos*, November and December, 1908; January and February, 1909.

rhage. In addition to the changes in the follicle already referred to, he finds certain histo-chemical alterations in the enamel and dentine.

The diagnosis of syphilitic teeth. Syphilitic incisors must be diagnosed from (*a*) the tapering notched tooth occasionally seen in patients who have suffered from rickets; (*b*) hypoplastic incisors, where the deformity is confined to the edge and the central portion wears down more rapidly than the side. The notch produced upon the teeth by the use of a clay pipe ought not to be mistaken for a syphilitic notch, as it is unilateral and altogether different in character. The diagnosis of congenital syphilis can also be confirmed by the presence of other lesions, such as scars radiating from the angles of the mouth, dusky-coloured skin, prominent forehead, broad depressed bridge of nose, and interstitial keratitis. Children who suffer from phagedænic ulceration of the mouth, syphilitic in origin, are generally free from the typical teeth.

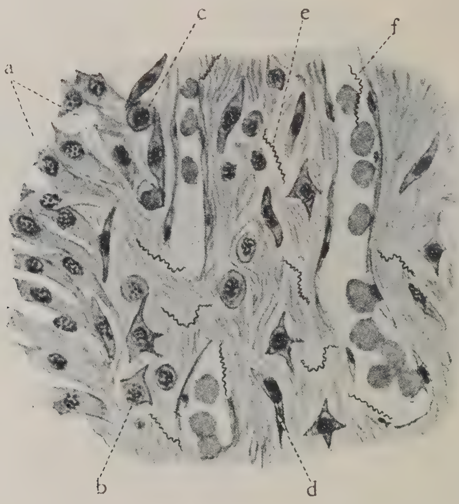

FIG. 138 (from part (*c*) of fig. 137).

(*a*) Odontoblasts of irregular shape and distribution.
(*b*) Polygonal cells
(*c*) Round cells } of the dental papilla.
(*d*) Fusiform cells
(*e*) *Spironema pallidum* situated in the gelatinous tissue of the dental papilla.
(*f*) *Spironema pallidum* situated in the lumen of a capillary and partly attached to the endothelium.

It is well to remember that the diagnosis of congenital syphilis by no means rests upon the presence or absence of these teeth, for they are only met with in a small proportion of cases. H. Moon has suggested an explanation of the deformity. He believes that "the peculiar shape results from a stunted development of the first formed portion of dentine, in other words, a dwarfing of the cusps; and that the single central notch on their cutting edge is due to a greater diminution in the size of the central than the lateral lobes."

The lesions on the teeth caused by syphilis are usually found on the incisors and first molars of the permanent series, and this is to be attributed to the fact that the maximum intensity of the virulence is during the last months of intra-uterine life and the first three months of extra-uterine life, which is the period when those teeth are forming. Welander[1] reports a case of a lad who acquired syphilis when between three and four months of age from his nurse. In this patient, the teeth characteristic of syphilis were present.

The deciduous teeth do not always escape and the characteristic lesion is occasionally met with in the incisors.[2] The probable explanation of the comparative immunity of the deciduous teeth is that they are formed in the early months of uterine life when syphilis rarely manifests itself, and if it does appear during that stage it usually tends to abortion.

(2) Hypoplastic Teeth (Honeycombed Teeth).—To the naked eye this condition is characterized by a defective formation of the enamel, accompanied, in many cases, by a stunted growth of the portion of the tooth affected.

In the type of hypoplastic teeth usually met with, the first molars, together with the incisors and canines, are affected, the defect extending from the cutting edges, and involving, in severe cases, the whole of the crown surfaces. In mild cases the enamel presents only a slight pitting; in more advanced conditions the enamel is dark in colour and presents numerous deep pits; while in severe cases the enamel covering is slight and the cutting edge of the tooth presents sharp points which give the tooth a curious spine-like appearance. In another variety the enamel is simply deficient in quantity and shows little or no pitting. In some cases the rows of pits run transversely across the tooth separated from one another by well-formed enamel; while other examples are seen in which the surface of the tooth shows transverse grooves, the enamel everywhere presenting a smooth, glossy appearance. In rare instances the defects run in a vertical direction. Occasionally the enamel towards the cutting edge of the tooth may be well formed, the defect starting beyond this point. The extent of the deformity may be limited to a transverse band of tissue situated in any part of the crown. Examples of hypoplastic teeth are shown in figs. 139 to 142.

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[1] *Nord. Med. Archiv*, vol. 27, No. 3.

[2] See case recorded by G. F. Still, *The Practitioner*, July, 1904.

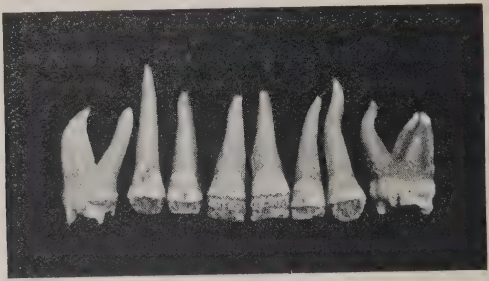

FIG. 139.—Hypoplastic maxillary incisors, canines and first molars from the mouth of a patient who had suffered from rickets.

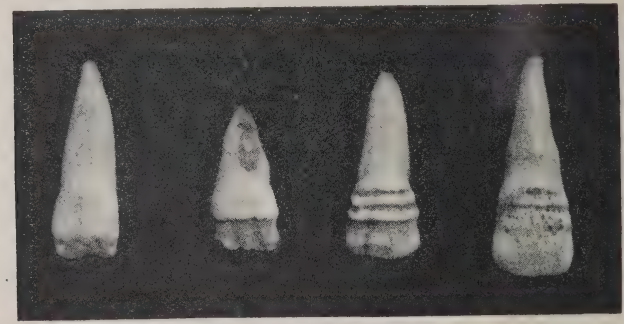

FIG. 140.—Examples of hypoplastic maxillary first incisors.

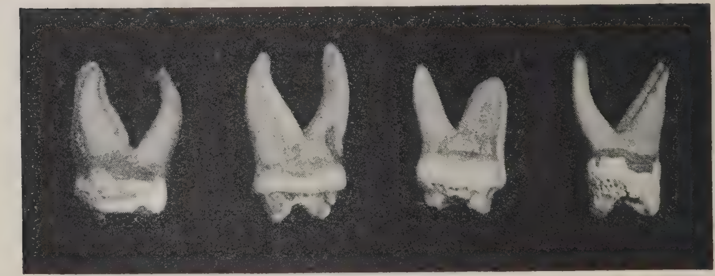

FIG. 141.—Examples of hypoplastic maxillary first molars.

As previously mentioned, the incisors, canines and first molars are the teeth usually involved in severe cases; the premolars, second and third molars may also be affected. On the other hand, the deformity may be limited to the occluding surfaces of the first molars. In cases where the defect in the incisors is limited to the centre of the cutting edge, this portion wears down at a greater pace than the sides, and a well-marked notch is produced which must be carefully discriminated from the notch resulting from syphilis.

Hypoplastic teeth are met with in the deciduous dentition. A. T. Pitts[1] found 15 cases in 4,000 children. The canines and second molars are the teeth usually affected. The hypoplasia may consist in a " stippled " erosion of the enamel on the buccal surface. In more severe cases the cusps may be affected or there may be a definite diminution in the size of the tooth.

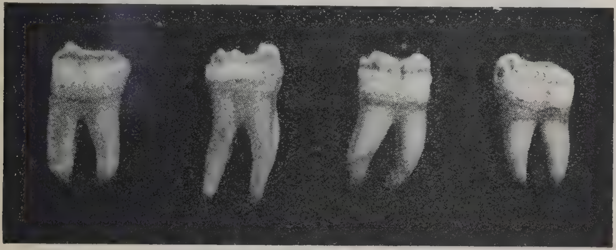

FIG. 142.—Examples of hypoplastic mandibular first molars.

In a child seen, aged two years six months, the molars, canines and mandibular second incisors were affected. The child had been fed on condensed milk.

In the skulls of monkeys and other animals showing rickets hypoplastic teeth are occasionally seen. The specimen shown in fig. 143 is from an Abyssinian lion about 5 years old. The canines, from the tips to half-way up the crowns, are practically devoid of enamel, and the incisors, premolars and molars all show defective enamel in places The *post-mortem* on this animal revealed a condition simulating acute osteo-arthritis.

Microscopical Appearances.—The enamel will be found to be extremely thin in the position of the pits or grooves, and may be entirely absent. The striation of the enamel prisms is generally well marked, and the condition known as the " brown striæ of Retzius " is also present. In severe cases the enamel in parts

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[1] *Proc. Roy. Soc. Med.* (Odonto. Soc.), vol. xiv, p. 28.

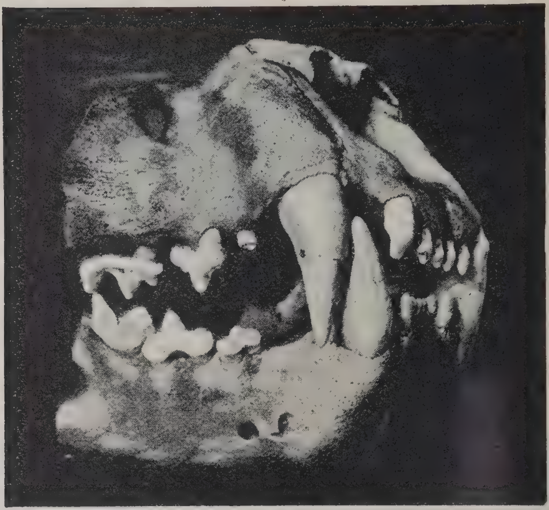

FIG. 143.[1]

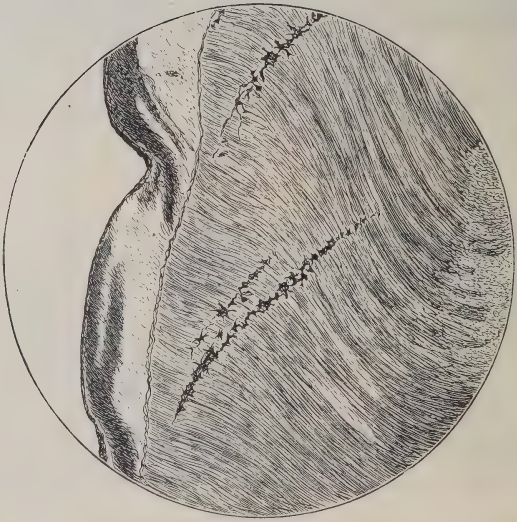

FIG. 144.

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[1] From *Trans. Odonto. Soc.*

appears as a homogeneous brown mass. The dentine is seen to contain a large number of interglobular spaces, and in those teeth where the cause has acted intermittently these spaces will be found arranged in rows taking an upward and inward direction and corresponding to the pits or rows upon the enamel (see fig. 144).

J. E. Grevers of Amsterdam has pointed out that in some cases the defect visible on the surface is continued through the whole thickness of enamel.

Etiology.—In looking for the cause of the deformity it must be remembered that the period at which the deformed enamel was being calcified must synchronize with the activity of the supposed cause. In most cases the malformation is on the crowns of the incisors, the canines and the first molars. This points to a cause acting during the first two years of life. Jonathan Hutchinson attributed the deformity to a stomatitis arising from the use of mercury. It will frequently be found on inquiry that patients with hypoplastic teeth were given mercury for convulsions, &c., during teething; or some form of teething powders containing mercury was used. On the other hand, many patients come under notice to whom no teething powders have been administered, yet the hypoplastic teeth are present; and, conversely, cases are seen where teething powders containing mercury were freely administered during the process of teething without apparent effect upon the structure of the teeth.

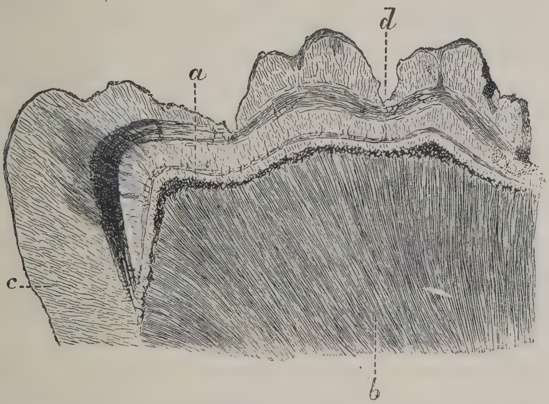

FIG. 145.—Section through a hypoplastic molar. *a*, interglobular spaces; *b*, dentine; *c*, enamel; *d*, a pit upon the masticating surface.

It has been asserted that the epileptiform convulsions which are associated with hypoplastic teeth during infancy cause the tooth deformity, while others blame the mercury which is administered to cure the convulsions. But these explanations are not satisfactory, and in this connection the following case is of interest. A patient had three attacks of convulsions during teething. No mercury was administered. The enamel of the patient's teeth was slightly deformed. The other members of the family had no convulsions, but nevertheless teething powders were freely administered. Their teeth remained normal. This case tends to show an association between convulsions and defective tooth development, but there is nothing to fix the relationship as cause and effect, and it seems more rational to regard both as the effects of a common cause.

Kingston Barton, who has given much attention to this question and has kept careful records, states that in 202 children he found 10 cases of hypoplasia in the permanent and 5 cases in the deciduous series, the latter cases being restricted to hand-fed children, of whom there were 67. Out of the 202 cases, 54 were fully breast-fed, and in these no hypoplasia was present. He also adds that in two cases of very bad artificial feeding very early and extensive caries occurred.

During recent years an awakened interest in the subject of infant feeding has led to a diminution in the use of patent farinaceous foods, and coincident with the withdrawal of those foods a marked reduction has been observed in the number of children suffering from hypoplasia of the teeth.

Lamellar cataract is usually associated with hypoplastic teeth. N. G. Bennett[1] found the tooth abnormality associated with 22 out of 26 cases of lamellar cataract, and in 12 of the cases the defect in the molars extended up to or within an eighth of an inch of the gum margin.

Experiments conducted by M. Mellanby[2] on puppies show that when the diet is deficient in a vitamine somewhat similar in distribution to fat soluble A the teeth may show defective formation. In such cases the enamel of the teeth is deficient in quantity and poor in quality, and the dentine shows an abnormal number of interglobular spaces. This deficiency in the calcification of the teeth is associated with poor formation of bone, osteoid tissue in a large measure replacing the normal bone.

Hypoplasia characterized by a single horizontal band of defective tissue can usually be traced to one of the specific fevers, although exanthemata occurring during infancy will not in every case affect the teeth. The facts which point to the exanthemata being the active cause in some cases are, briefly (1) that in children who have had one of the eruptive fevers during infancy, but who are otherwise healthy, distinct structural defects are sometimes present; and (2) that the period during which the defective portion of the tooth was calcifying synchronizes with the attack of the fever. Measles seems to produce the deformity most frequently, and, next after measles, scarlet fever.

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[1] *Trans. Ophthal. Soc.*, vol. xxi.

[2] *Dental Record*, vol. xl, p. 65; vol. xlii, p. 1.

Reference may here be made to a condition termed "Mottled teeth,"[1] which has been fully described by F. S. McKay and G. V. Black. The defect of the enamel consists of "minute white flecks or yellow or brown spots or areas, scattered irregularly or streaked over the surface of the tooth, or it may be a condition in which the entire tooth surface is of a dead paper-white like the colour of a china dish. In many cases the surface of the tooth is dotted with irregular, shallow pits, which are usually darkly discoloured because of the lodgment of débris. Any or all of the teeth may be mottled or certain groups only; or the area of some teeth either above or below a certain point may be mottled, and the rest of the enamel of such teeth be practically normal."

The essential malformation is a failure of the cementing substance between the enamel rods on the outer one-fourth to one-third of the surface of the enamel. In about 40 per cent. of the cases a colouring matter—named by Black "brownin"—is formed in place of the cementing substance. This discoloration is not present when the teeth erupt, but gradually makes its appearance and is usually located on the labial aspects of the anterior maxillary teeth.

This hypoplasia of the enamel was met with in certain well-defined areas in the Rocky Mountains, and occurred only in those individuals who were born in any of these areas or who had lived there continuously during the period of enamel formation.

Piergili[2] states that quantitative analysis has revealed a common characteristic in the waters of the regions wherein this dental lesion is endemic; a minimum content of mineral salts in general, and of the salts of calcium in particular. This minimum content of calcium salts is the cause of the condition which produces mottled teeth. Water with its dissolved carbon dioxide has chemical affinity for calcium carbonate, and unless this affinity be satisfied before water is taken into the mouth the calcium carbonate in the teeth will be dissolved out if the teeth have not reached a certain degree of hardness.

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[1] *Dental Cosmos,* February and May, 1916.

[2] *La Stomatologie,* March, 1918.

Mention must also be made of the condition sometimes termed "piebald teeth," in which the enamel is not deficient in quantity but presents a patchy white appearance. Microscopical examination of these teeth shows a defective calcification of the enamel.

(3) Hereditary hypoplasia of the teeth is a rare condition. In the mildest form the enamel is well formed but shows numerous shallow pits. Both deciduous and permanent teeth are usually affected. In one case under observation this condition was present in two children, the father and the grandmother.

With an increase in the deficiency of the enamel, the teeth may appear of a dark brown colour (fig. 146). A case of this character was recorded by S. Spokes.[1] There were grooves in the long axis of the tooth, and in some places there was a total absence of enamel, while in other places the enamel was present in irregular patches. The family history of the patient revealed the fact that a similar condition existed in many members of the family, and that the deciduous as well as the permanent dentitions had been affected. The character of the teeth was examined in forty-two individuals extending over four generations, of whom twenty-three had defective enamel.

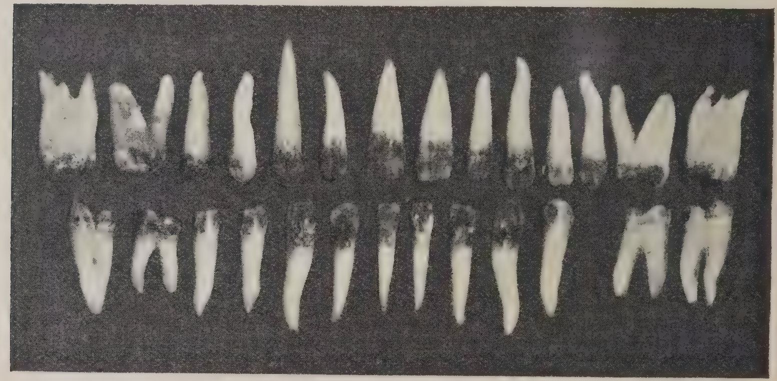

FIG. 146.—Teeth from a case of hereditary hypoplasia.

The enamel of the teeth illustrated in fig. 146 showed but little typical enamel structure; it was dense and admitted of very little penetration by the fuchsin stain.[1]

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[1] *Trans. Odonto. Soc.*, June, 1890, p. 229.

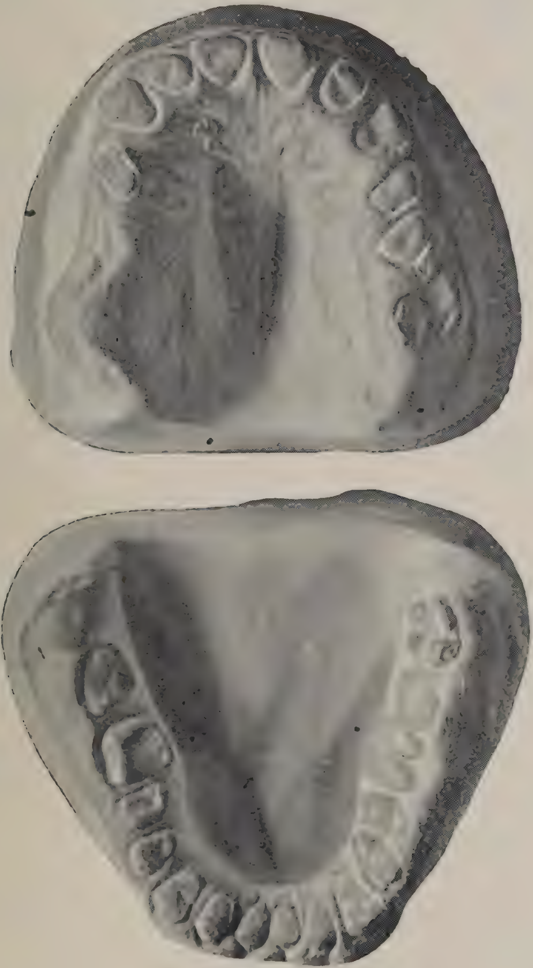

FIG. 147.[2]

In severe forms of hereditary hypoplasia as shown in fig. 147 there is a deficiency in the dentine as well as in the enamel. An excellent account of a family exhibiting this type of hypoplasia was recorded by J. G. Turner,[1] who was able to trace the defect through five generations. Of the fifty individuals composing the table, twenty-one showed the abnormality (fig. 148). The abnormal condition was always transmitted through abnormals. The defect took

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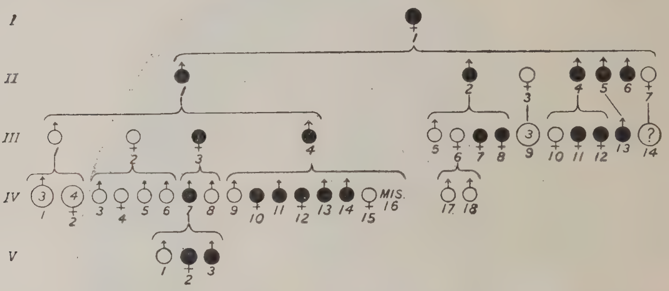
[1] The histological examination was carried out by J. H. Mummery.

[2] From the Royal Dental Hospital Reports, 1910.



● indicates an affected person.

○ indicates an unaffected person.

A large circle indicates a childship. The figure inside indicates the number of children. Where sex is known it is added.

FIG. 148.[2] (Turner.)

the form of a stunting of the teeth accompanied by marked defect of the enamel, both the deciduous and the permanent dentitions being affected. The number of teeth varied in the different individuals. The earlier formed teeth were most affected and in all the cases the third molars, when present, had a full covering of enamel.

An examination of the teeth from a case of this type of hypoplasia showed imperfectly formed enamel and the dentinal tubes arranged in bundles with, here and there, irregular bulgings.

(B) DEFECTS DUE TO LOCAL CAUSES

Defects in tooth structure may, in rare instances, be produced by local causes. The malformation is usually limited to a single tooth and may take the form of a pit, ring, or patch, or it may extend to the total absence of enamel. The premolars are usually affected, and S. Spokes finds that the condition is more frequently seen in the mandibular premolars and in the second more than in the first. In one case of local defect which came under notice, the distal half of the maxillary left canine was covered with small pits, the mesial half being quite normal (see diagram, fig. 149). In another instance a patient had a distinct line of pits half-way down the mandibular right first incisor, and the mother recalled the fact that the child had sustained a severe blow which injured the deciduous predecessor and led to its early loss. (See also chapter on Injuries of the Teeth.)

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[1] *Trans, Odonto. Soc.*, vol. xxxix, p. 137.

[2] From *Trans. Odonto. Soc.*

In many cases where a single premolar is affected distinct evidence of suppuration in connection with the deciduous predecessor can be obtained.

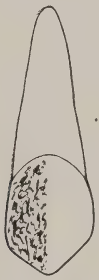

Fig. 149.

In two cases observed there was a small defect situated in the upper half of the maxillary first incisor. There was no history of injury, and in both cases the teeth were smaller than those of the opposite side.

In a few cases one of the first permanent molars may show a hypoplastic condition of the buccal cusps, the other teeth being quite normal.

A. T. Pitts states that he has seen two cases of local hypoplasia in the deciduous teeth:—

(1) A maxillary second molar failed fully to erupt; the crown was dwarfed and cone-shaped. (2) A maxillary first molar with the antero-buccal part affected; a sinus appeared in the region of this tooth three weeks after birth, the tooth erupting at six months.

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CHAPTER V

Abnormalities in Position of the Teeth

General Considerations—Etiology

(A) GENERAL CONSIDERATIONS

(1) NORMAL ARRANGEMENT OF THE TEETH

Before discussing the abnormal positions in which teeth are found it is necessary to determine what are to be regarded as their normal positions.

In this connection it is to be borne in mind that the arches formed by the teeth vary to a considerable extent both racially and individually.

(*a*) **The Deciduous Teeth.**—If the mouth of a well-developed child of the age of five be examined, it will be noticed that the maxillary and mandibular teeth are arranged in arches with regular curves. The maxillary teeth form an arch which is greater than the arch of the mandibular teeth, and consequently they overlap the mandibular teeth on occlusion. On a close examination of the occlusal arrangement it will be seen that the maxillary first and second incisors overlap the mandibular first and second incisors in addition to the anterior half of the canine; the maxillary canine overlaps the posterior aspect of the mandibular canine and the anterior third of the first deciduous molar; the maxillary first molar occludes with the posterior two-thirds of the mandibular first molar and the anterior third of the second molar; the maxillary second molar occludes with the posterior two-thirds of the mandibular second molar and projects a little beyond it (fig. 9).

(*β*) **The Permanent Teeth.**—In the English race the usual arrangement is as follows: The canines and incisors form the arc of a circle; the premolars and the first and second molars pass back from the canines in straight lines diverging slightly outwards; the third molar is placed a little internal to the arch. Variations from this arrangement are not uncommon; for example, the premolars and molars may be arranged on a well-marked curve or in a perfectly straight line diverging outwards only very slightly.

The arch formed by the maxillary teeth is greater than that formed by the mandibular. The maxillary first and second incisors overlap the mandibular first and second incisors, the maxillary second incisor also overlapping the anterior half of the mandibular canine; the maxillary canine overlaps the distal half of the canine and the anterior half of the mandibular first premolar; the maxillary first premolar occludes with the posterior aspect of the mandibular first premolar and the anterior aspect of the second premolar; the maxillary second premolar occludes with the posterior half of the mandibular second premolar and the anterior third of the mandibular first molar; the maxillary first molar occludes with the posterior two-thirds of the mandibular first molar and the anterior third of the second molar; the maxillary second molar occludes with the posterior two-thirds of the mandibular second molar and the anterior third of the third molar; the maxillary third molar meets the posterior two-thirds of the mandibular third molar.

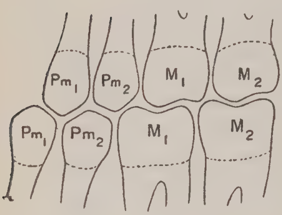

Fig. 150.[1]

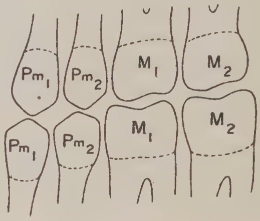

Fig. 151.[1]

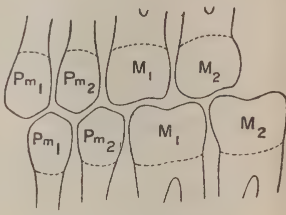

Fig. 152.[1]

In referring to the occlusion of the teeth, the following notation will be adopted:—

N, to indicate that the occlusion of the teeth is normal, fig. 150.

X, to indicate that the mesial surfaces of the molars or premolars are flush, fig. 151.

O, to indicate that in occlusion the mesial aspects of the maxillary molars or premolars are in advance of the mandibular, fig. 152.

Any deviation from the arrangement described above must be regarded as abnormal, but before dealing with the causes of abnormalities of the teeth it is necessary to review briefly certain points in connection with the development and growth of the jaws and arches.

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[1] From *Proc. Roy. Soc. Med.*

(2) DEVELOPMENT AND GROWTH OF THE JAWS

The maxilla, formed from the maxillary process, arises as a membrane bone external to the cartilaginous nasal capsule and in the neighbourhood of the canine tooth germ by one centre of ossification. From this centre three processes rapidly radiate:—

(i) A nasal process which grows upwards.

(ii) An alveolar process which grows downwards, is thickened at its root to form the malar process, and might be called the alveolo-malar process.

(iii) A palatine process which grows inwards.

The premaxilla is formed from the meso-nasal process and fuses with the maxilla about the third month, the maxilla overlapping and almost excluding it from the face.

The mandible is developed in membrane as a single element, and its growth is determined to a great extent by that of the maxilla. At birth, the mandible consists of two halves joined by fibro-cartilage, and at about the sixth month the two segments unite. It is possible that the segments grow to some extent before they unite.

In the **maxilla** at birth, the tooth germs lie in close proximity to the orbital plate, the sinus being represented by a slight depression internal to and just above the follicle of the second deciduous molar. The crypts of the incisors and canines are complete, but between the first and second molars the septum is still imperfect. The second incisor lies slightly posterior to the first incisor, and the crypt of the first molar is in close proximity to it, the canine lying between and anterior. As the time for the eruption of the incisors approaches, the space between the second incisor and the first molar increases, the growth of bone at this point continuing until the eruption of the canine. There is reason to suppose that room is made in the arch for the canine by growth of bone at the suture between the premaxilla and the maxilla.[1] With the eruption of the second molars the deciduous dentition is complete. An examination of the mouth at this stage will show an interval between the first molar and the end of the alveolar ridge. This interval increases in size until the advent of the first permanent molar. A skull examined at this period, namely, about six years of age, would show the following condition: In the **maxilla** the second incisors are placed slightly posterior to the first incisors and their direction is more vertical. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second more than the first. The first premolar is normally situated close to the second incisor. The canine lies above and external to the arch of the incisors and premolars and is directed slightly outwards. The first permanent molar will be in the process of erupting and the occluding surface will be directed outwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone, with its occluding surface directed downwards, outwards and well backwards. In **the mandible** the second incisors lie in a plane posterior to the first

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[1] See paper on "Abnormalities in Position of the Teeth in Man," *Dental Record*, February, 1914.

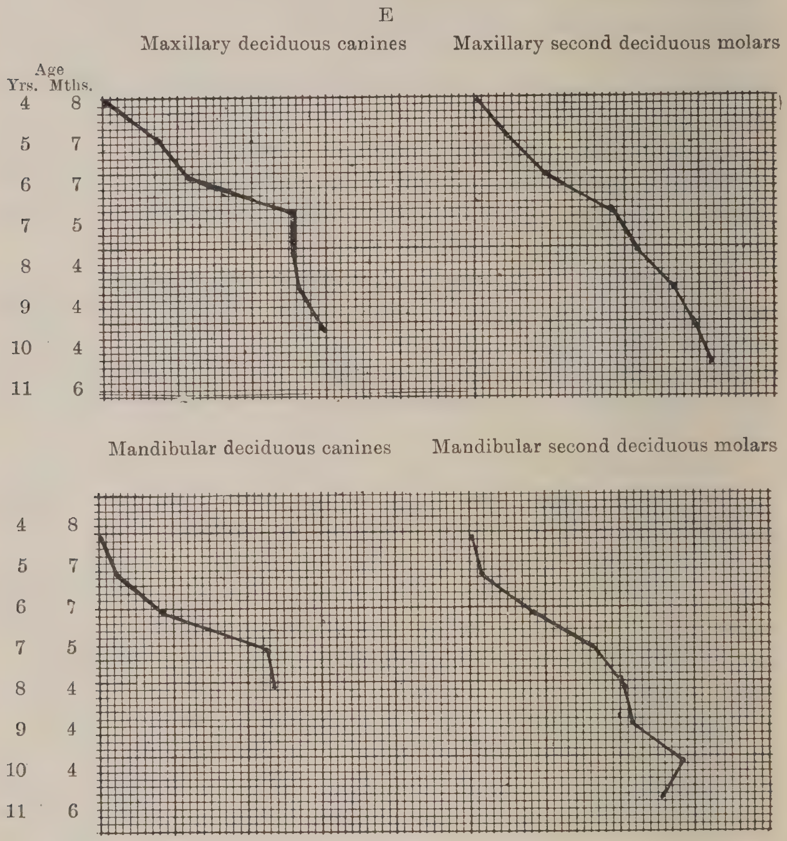

Fig. 153.[1]

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[1] From *Dental Record.*

incisors and the canines are placed near the lower border of the bone and lie in a plane anterior to the second incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards.

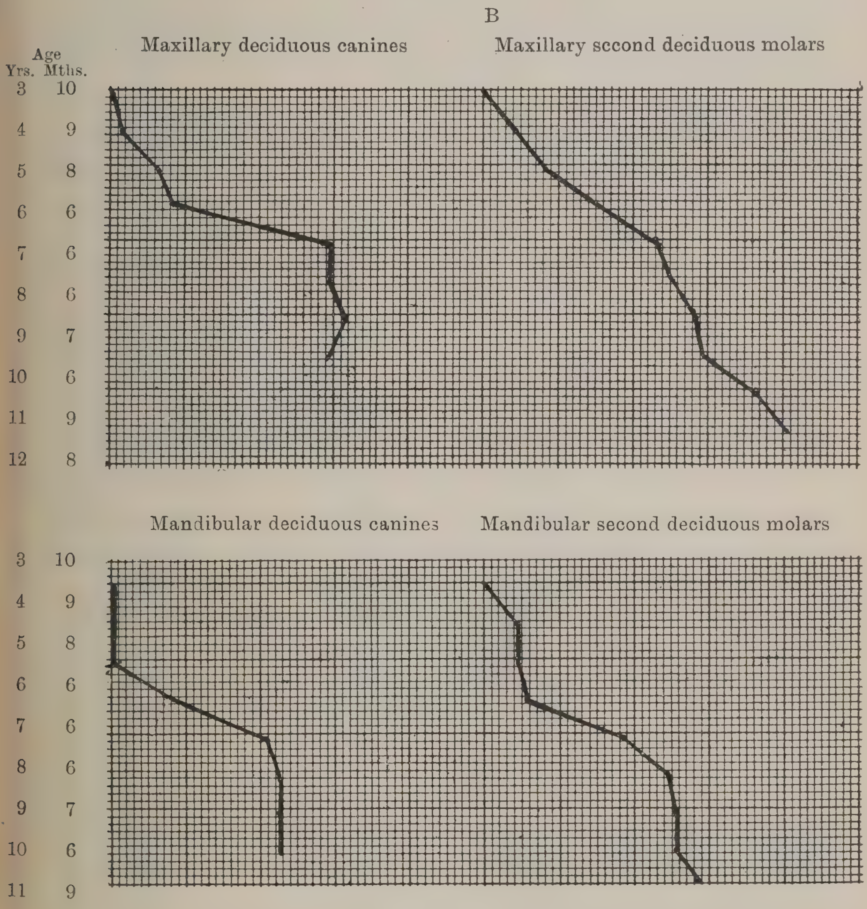

FIG. 154.[1]

The first permanent molars are directed upwards and forwards, the second being under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

During childhood there is a progressive increase in the size of the arch and in this way space is obtained for the permanent teeth, which are broader than the deciduous teeth, to assume a regular arch. The increase in the size of the arch can be demonstrated by taking models at regular intervals. The diagrams, figs. 153 and 154, were made from a series of models of two children of normal growth. The measurements were taken between the canines and the second deciduous molars with an instrument by means of which tenths of a millimetre could be registered. In the diagrams ten millimetres equal one millimetre of actual increase.

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[1] From *Dental Record.*

The diagrams show (1) that the principal increase in the inter-canine width takes place between the ages of six to eight years, a period corresponding to the eruption of the permanent incisors; (2) that the increase in width between the second deciduous molars is gradual in character. The slight decrease in width between the maxillary canines (fig. 154) was due to an inward displacement of the deciduous tooth by the erupting tooth.

The manner in which these changes in the arch are brought about is not clear. They have usually been attributed to a forward pressure exerted by the developing teeth, but this explanation is hardly satisfactory in view of the fact that the permanent canine lies above the deciduous canine and the premolars are embraced by the roots of the deciduous molars. There is some evidence that growth continues at the suture between the premaxilla and the maxilla during the first years of life, and A. Keith is of the opinion that growth also occurs along the median suture of the maxilla.

The growth of the maxilla backwards provides room for the permanent molars. The growth of the maxilla in this region has been shown by Keith[1] to be dependent on the expansion of the maxillary sinus. At birth the position of the sinus is marked by a slight depression just above the follicle of the second deciduous molar. This depression spreads towards the orbital plate, and, at the end of the first year, has developed forwards over the first deciduous molar and backwards over the first permanent molar, an extension of the sinus rapidly taking place as the remaining molars are formed.

The effect of the growth of the maxillary sinus on the eruption of the teeth can be studied by examining the relation of the teeth to the sinus in a sixth-year skull. The first permanent molar lies in close relationship to the sinus, with the occluding surfaces facing downwards and backwards. "As the tooth moves into position, it rotates so as to bring its crown downwards and backwards, while the sinus spreads downwards and backwards between the roots of the teeth. The growth of the sinus wheels, as it were, the tooth into position. An exactly similar condition occurs with the second and third molars."

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[1] "The Expansion of the Maxillary Antrum," A. Keith, *Brit. Journ. Dent. Sci.*, June 16, 1902.

"The fulcrum on which this rotation of the bone takes place is formed by the body of the sphenoid, the anterior surface of its great wing, and the pterygoid plates, mainly the internal." (See fig. 155.)

In the mandible the replacement of the deciduous teeth by the permanent teeth takes place in the same manner as in the maxilla,

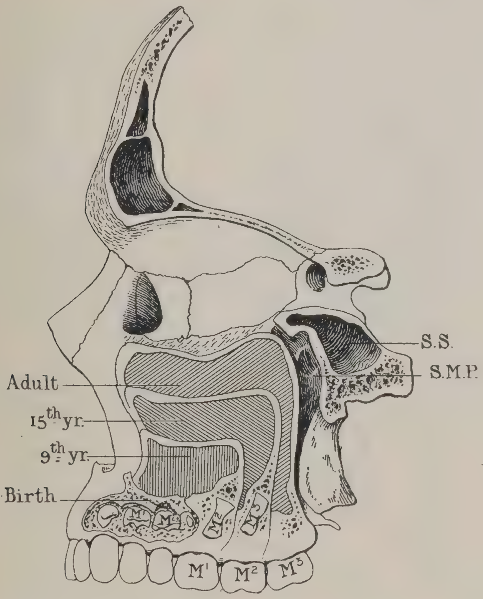

Fig. 155.—The above drawing by A. Keith illustrates the position of the developing molars and the relation of the maxilla to the pterygoid processes. "The diagram is drawn to scale and is founded on material in the museums of the Royal College of Surgeons and of the London Hospital. Four stages are shown: (1) at birth, (2) at the 9th year, (3) at 15th year, and (4) in the adult. . . . While the diagram demonstrates clearly the growth changes which occur in the jaw, it must not be forgotten that, in the body, the postero-superior border of the sinus is the fixed, and not the moving point as represented in the diagram."

the space for the molars being obtained by a backward growth of the bone, this growth being correlated with the growth of the maxilla consequent on the expansion of the sinus. A recognition of these phenomena is necessary in studying the pathology of certain types of irregularities of the teeth.

In a paper, which students are recommended to study,[1] A. Keith and G. G. Campion have shown that the growth of the jaws is intimately correlated with the growth of the whole apparatus of mastication. The general nature of the growth-machinery involved is discussed with the view of showing the direction in which research is required. This paper lays stress on the close connection between

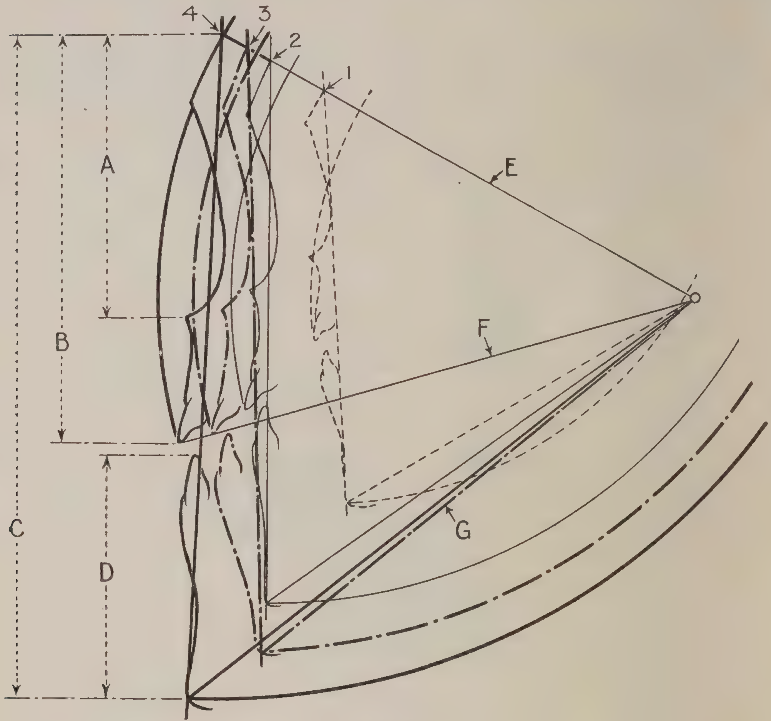

FIG. 156.[2]

FIG. 156.[2]—Diagram showing vertical and forward growth of the normal or sub-normal face. Vertical measurements taken from nasion; forward movements from trans-meatal axis. The arcs centred at the meatal axis show the progressive growth forwards along line F in relation to that along line E. The arcs centred at the nasion show the progressive vertical growth along line C in relation to that along line E.

Profile 1.—From child aged 3 years 6 months.
,, 2.—Represents mean of 10 children aged 9 to 11 years.
,, 3.—Represents mean of 9 children aged 15 to 16 years.
,, 4.—Represents mean of 10 adults.

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[1] "A Contribution to the Mechanism of Growth of the Human Face," *Dental Record*, February 1, 1922. A paper read before the British Society for the Study of Orthodontics.

[2] Figs. 156 to 158 have been made from drawings kindly lent by A. Keith.

irregularities of the teeth and other changes in the face and cranium.

The methods pursued were as follows:—

Measurements were taken to show growth in a sagittal plane, a line between the external auditory meati being taken as the base. From this base, measurements were made to the nasion E, the edge of the maxillary incisors F, and the mental eminence G. The measurements were carried out in individuals of four age periods—3 years and 6 months; 9 to 11 years; 15 to 16 years, and adults. The growth in height was obtained by measuring from the nasion

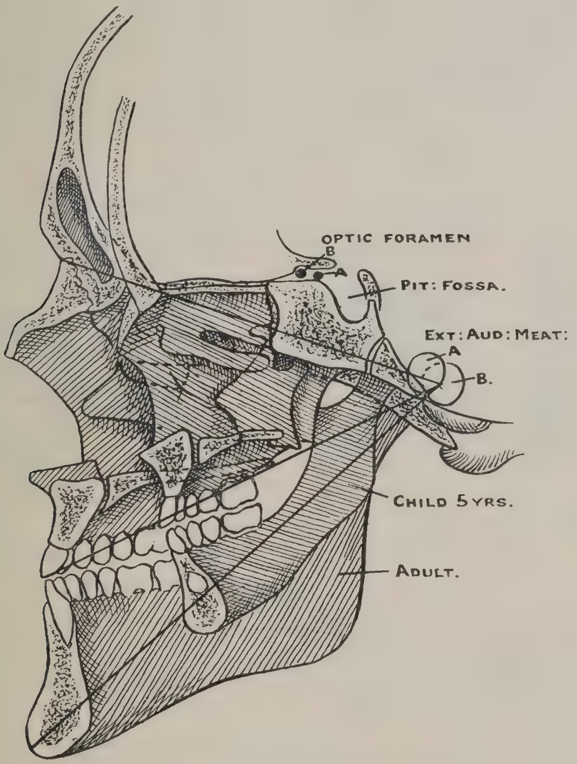

FIG. 157.

(⅔ natural size.)

A.—Sagittal mesial section of the skull of a child with M_1 about to erupt and estimated to be 5 years of age.

B.—Corresponding section of skull of adult Englishman. The skulls are superimposed so that the pituitary fossæ and cribriform plates correspond. The sections show the amount of growth in the sagittal mesial plane from the 5th to the 25th years.

to the sub-nasal point (A), the maxillary incisors (B) and the sub-mental point (C); the growth in height of the front part of the mandible was obtained by measuring a line drawn from the top of the mandibular incisors to the sub-mental point (D). These lines of measurement are shown in fig. 156.

The region in which growth occurs can be ascertained by superimposing sagittal mesial sections of skulls of different ages, as shown in fig. 157. The skulls are superimposed so that pituitary fossæ and cribriform plates correspond. It will be noticed that the line E crosses three important sites, viz., fronto-nasal, spheno-ethmoidal junction, spheno-occipital junction. By superimposing these different elements as shown in fig. 158 an idea can be obtained of the relative growth in these situations. The authors found that in line E, the amount of growth in the fronto-nasal region was a superficial deposit; at the fronto-ethmoid junction it was restricted; but marked at the spheno-ethmoidal junction. This latter junction is concerned in providing space for the erupting molars, a subject already referred to on p. 108.

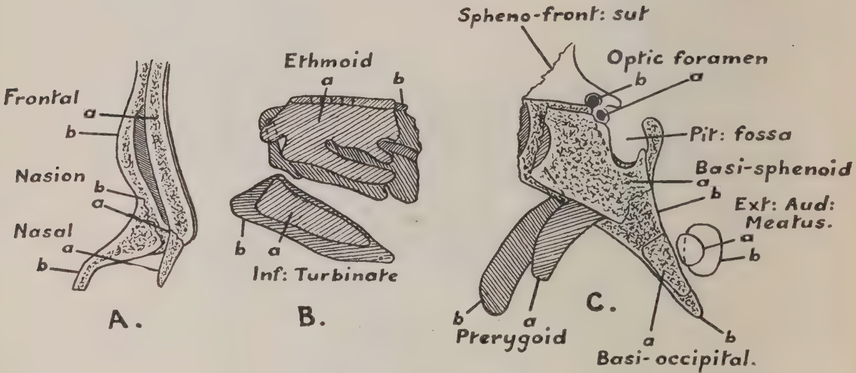

FIG. 158.

($\frac{2}{3}$ natural size.)

Sites of growth along line E in basal parts of skull: (*a*) child, aged 5 (see fig. 157); (*b*) adult (see fig. 157). A, fronto-nasal element; B, ethmoidal element; C, sphenoidal element.

The growth sites crossed by the line F are the posterior area of the maxilla—the area lying in front of the pterygo-maxillary fissure, where the molar part of the alveolar margin is produced—and the palate bone, new tissue being added on both anterior and posterior margins.

The deposit of bone in the suture between the maxillary and palate bones takes place, in the authors' opinion, at a greater rate than at the posterior part of the maxilla. Growth also takes place along the palatal or lower border of the vomer to keep pace with growth in front of the pterygo-maxillary fissure.

Along the line G growth is chiefly in the region of the condyle and, in a small degree, in the region of the chin.

Growth also occurs at various superficial sites and sutures, at the junction of the temporal and malar bones, the addition being equal with that laid down on the posterior part of the maxilla. At the malo-maxillary suture the growth is less. Important growth takes place at the fronto-nasal process, along the supra-orbital margin, and at the external angular process.

The authors' observations show that the great coronal system plays an important part in the growth of the jaws; this system includes the coronal suture itself, the temporo-malar, the fronto-sphenoid, spheno-ethmoid, pterygo-maxillary, and transverse suture of the palate.

By superimposing the skull of a prehistoric inhabitant of these islands with a well-developed palate upon the skull of a modern inhabitant with a contracted palate, the authors show that the contraction of the palate in the latter case is due to a general lack of growth of all the parts concerned in the general growth of the face.

The conclusion they reach is that the so-called adenoid face is due not to simple mechanical causes but to an arrest or disturbance of the elaborate machinery which underlies facial growth.

"*The normal orderly arrangement of the teeth in the jaws is the result of normal growth of the bone.* The teeth may react on the bone, but the main factor in the translation of the teeth to their normal position in the arch is the work of the growing bone. In other words, the arrangement of the teeth in a normal arch is not necessarily dependent on want of room in that arch."[1] (Further reference will be made to this point in dealing with adenoids.)

(3) FACTORS INFLUENCING THE GROWTH OF THE JAWS

The growth of the jaws is materially affected by functional activity. It will be convenient to deal with this subject under the following heads:—

(*a*) The influence of mastication.
(*β*) The function of the teeth.

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[1] J. G. Turner, "The Influence of the Growth of Bone in the Arrangement of the Teeth," *Dental Cosmos*, vol. xlvii, p. 43.

(γ) The action of the tongue.

(δ) The nasal function.

It may here perhaps be pointed out that the proper function of a part is necessary for the due growth of that part, as instanced by the mal-development of the orbit which follows the loss of an eye in youth.

(*a*) **The Influence of Mastication.**—In considering the influence of mastication on the jaws a brief reference must be made to the relation of the muscles to the bones. Fig. 159 is a vertical transverse (slightly oblique) section through the head on a level with the epiglottis, showing the massiveness of the masticating muscles. Fig. 160 is a horizontal transverse section about an inch below the condyles of the mandible, showing the outward direction of the

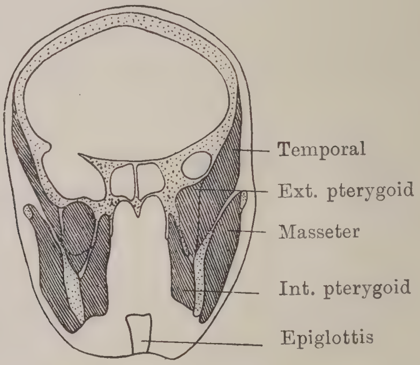

Fig. 159.[1]

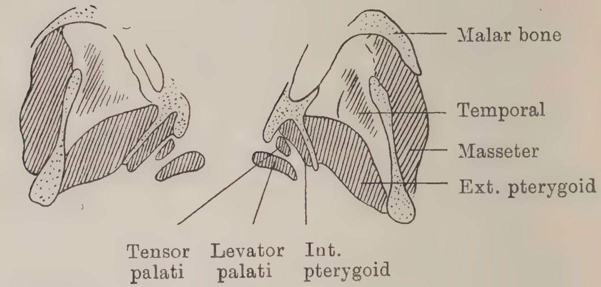

Fig. 160.[1]

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[1] Copied from the *Trans. Odonto. Soc.*, by kind permission of Harry Campbell.

external pterygoids as well as the close relation of the levatores and tensores palati with the internal pterygoids. From these figures it will be seen that " the pterygoids, when in a state of contraction, must exercise an outward and backward tug on the external pterygoid plate, palate bone, body of the sphenoid and maxilla, and tend to pull them away from the sagittal plane of the head."

Harry Campbell is of the opinion that, in addition to the actual mechanical action of the pterygoid muscles, their rhythmic contraction greatly aids the circulation of the blood and lymph and so exercises a beneficial effect on the structures in the immediate neighbourhood.

(β) **The Function of the Teeth.**—The positions occupied by the teeth influence the growth of the jaws. The teeth transmit the force of muscular action to the bones. Normally the maxillary teeth are arranged with the occluding surfaces of the premolars and molars facing slightly outwards, and the force applied to them in this position in mastication has a general tendency to expand the jaws. The more vertical the direction of the teeth the less will be the influence of muscular pressure towards increasing the width of the maxillæ.

(γ) **The Action of the Tongue.**—The tongue influences the position occupied by the teeth in the arch. Sim Wallace[1] considers that the tongue is the common denominator for the correlation of the upper and lower teeth, and that there is an intimate connection between the size and growth of the tongue and the size and development of the jaws. A large tongue, by causing the teeth to occupy a large arch, stimulates the outward growth of the jaws. The pressure of the tongue on the anterior part of the palate during the act of swallowing is probably an important factor in modifying this part of the mouth. In Wallace's opinion the under-development of the tongue and the decreased size of the jaws at the present day are to be attributed to the slight amount of mastication which is now necessary in the consumption of food.

(δ) **The Nasal Function.**—The perfect performance of nasal respiration is an important factor in the growth of the maxilla. The use of the muscles of the nose influences the growth of the premaxilla and the constant flow of air through the nasal passage stimulates the supply of blood to the mucous membrane lining the nasal fossa and the accessory sinuses and so stimulates the general growth of the bone.

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[1] A lucid account of Sim Wallace's views is to be found in his work on "Irregularities of the Teeth."

(B) ETIOLOGY

Adami, in his excellent work on Pathology,[1] makes some valuable general remarks in the introduction to the section on Causes of Disease, and these remarks may with advantage be quoted here because they will render more intelligible to the reader the account to be given of the causes producing irregularities in the position of the teeth. He states that "Every departure from the normal, whether in the cell, the organ, or the system in general, is a pathological condition, provided that we recognize that the 'normal' is not an absolutely fixed point, but is the expression for the limits between which the majority of the individuals of a given species will be found to group themselves as regards any particular attribute. Such pathological conditions must, it will be seen, be of two orders: either primarily due to some constitutional defect transmitted from the parent or parents (included with which we must place the effects of imperfections in the fusion of the male and female elements at the moment of fertilization. Such effects, being associated with the actual constitution of the individual, are of internal origin and inherited); or, in the second place, they may be the result of some influence which first affects the individual after his genesis. Such conditions are of external origin and acquired. Morbid conditions, then, are to be classified into inherited and acquired."

It is advisable to make quite clear what is understood by the term "inherited" as here used. To quote Adami, "That alone is inherited which is the property of the individual at the moment of his becoming an individual, which is part and parcel of the paternal and maternal 'germ plasm' from which he originates, or is provided by the interaction of the same." "It is unnecessary to point out, save as a precaution, that what is a property of the individual from the moment of beginning existence need not show itself for long years—a family failing towards premature baldness not until years after puberty, or an inheritance of gouty tendencies not until after thirty-five. As the different organs and parts assume their particular conformation and properties at different periods, and do not develop *pari passu*, so must the various inherited peculiarities make their appearance at various times."

The classification based on these principles and adopted by Adami is as follows:—

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[1] "The Principles of Pathology," by J. G. Adami.

(1) Inherited, due to influences affecting the ovum or the spermatozoon before or at the moment of fertilization.

(2) Acquired.

(*a*) Ante-natal or of intra-uterine acquirement.

(*b*) Parturient, acquired at the time of birth before complete separation of the individual from the maternal organism.

(*c*) Post-natal, acquired after birth.

There are objections to the application of this scheme to irregularities of the teeth. For example, it is often impossible to say with certainty whether a particular condition is due to an inborn predisposition or to an extrinsic stimulus; thus cases of cleft palate may be markedly hereditary, or, on the other hand, may be distinctly traceable to defective nurture. From a biological point of view, however, the scheme has the great advantage of being based on endogenous causes (variations) and exogenous causes (modifications), and it is proposed to adopt this classification in describing the various abnormalities in the position of the teeth.

(1) ABNORMALITIES DUE TO INHERITED CAUSES

(*a*) *Abnormalities due to Reduplication of Organs—Meristic Excess*

Irregularities due to the presence of supernumerary teeth are included in this group.

When supernumerary teeth are present in the arch, the normal arrangement of the teeth is necessarily disturbed (see example in fig. 161). The supernumerary tooth or teeth may erupt in the arch and cause perverted growth and non-eruption of the normal teeth. Thus in fig. 162 the maxillary right incisor is placed high up in the alveolar process, with its root considerably curved, and in fig. 163 two supernumerary teeth occupy the position of the maxillary first incisors, one of which is displaced and much contorted. The other incisor, which is missing, may have been removed before death.

(*β*) *Abnormalities arising from Defects of the Tooth Band*

The irregularities included in this group would seem to be due to the tooth bud being given off in an abnormal position.

It will be convenient to group under this heading cases in which there is extreme displacement of a tooth or teeth, but otherwise the arch is normally developed.

(i) *The Maxillary Canine.*—Developmental irregularities in the position of this tooth are common, and vary from a slight deviation from the normal to complete inversion of the tooth and eruption into the nasal fossa. This irregularity was noted in seventeen out of 1,000 men examined. In one case both maxillary canines were misplaced and in another case the left maxillary and the right

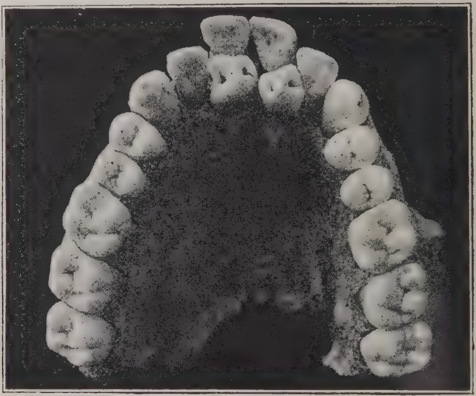

Fig. 161.—Maxillæ with two supernumerary teeth causing irregularity of the first incisors.

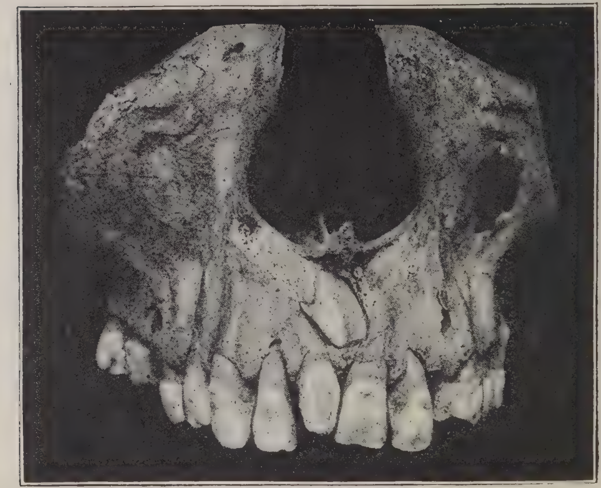

Fig. 162.—Maxillæ with the right first incisor embedded in the bone. A supernumerary tooth is present in the arch.

mandibular canines were affected. The following specimens show a progressive degree of irregularity:—

In fig. 164 the canine has erupted internal to the arch and caused slight irregularity in the position of the second incisor. In fig. 165 the left canine has erupted in a vertical position internal to the arch, whilst the right canine has assumed an oblique direction, the crown lying in the palate behind the incisors and the root being embedded in the bone in close contact with the roots of the premolars. In fig. 166 the canine has entwined itself around the alveolar process, the crown projecting in the palate and the root appearing just under the outer alveolar plate. A further stage is marked by the misplaced tooth lying external to the dental arch in a horizontal position, as seen in fig. 167. Next the tooth takes an upward turn, as seen in fig. 168, piercing the gum high up on the alveolar process; while in the final stage there is complete inversion,

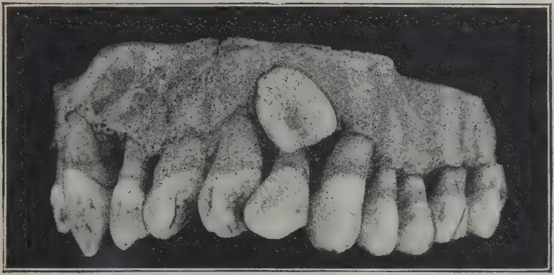

Fig. 163.—Portion of maxillæ with two supernumerary teeth erupted in the arch. The left first incisor is displaced.

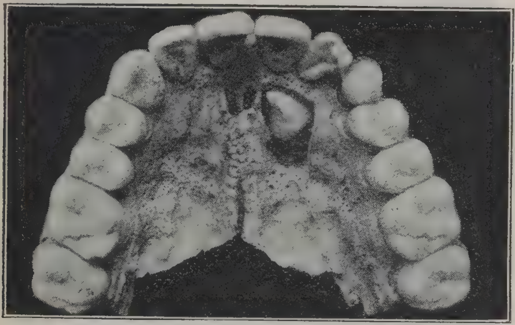

Fig. 164.—Maxillæ with the left canine erupting internal to the arch.

as in fig. 169. In the last specimen the condition is symmetrical; both teeth are embedded in the nasal process of the maxillary bones. In the specimen shown in fig. 170 the tooth has worked its way into the nasal fossa. In the foregoing examples the canine has failed to erupt. In other cases of extreme displacement, however, the canine erupts but assumes a position in the arch which should normally be occupied by another tooth. This irregularity is generally

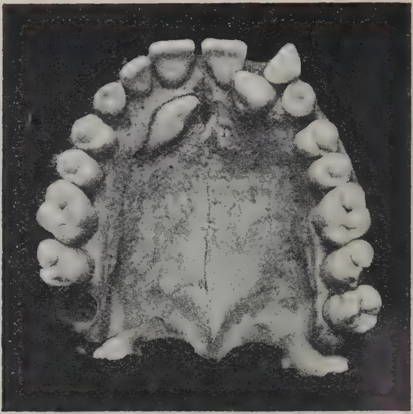

FIG. 165.—Maxillæ showing misplaced canines.

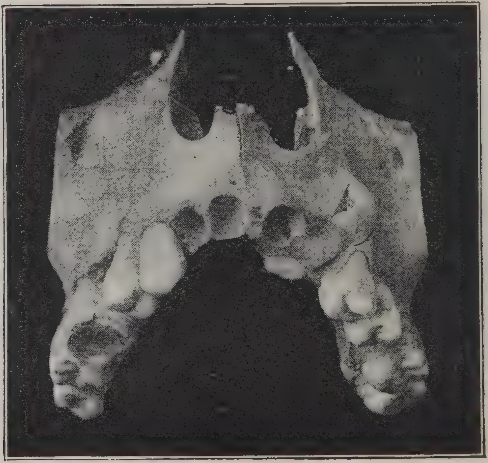

FIG. 166.—The left canine is lying horizontally across the alveolar process.

termed "transposition," and is probably due to an inherent defect in the position of the tooth germ. In such cases the canine and second incisor usually change positions, and less commonly the canine and first premolar are transposed. In rare instances the canine may erupt posterior to both premolars.

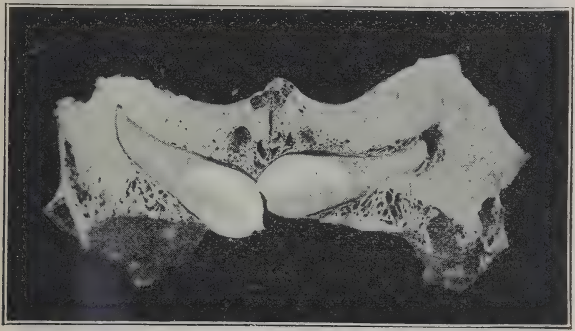

FIG. 167.—Portions of the maxillæ showing the canines lying in a horizontal direction with the crowns directed towards the median line.

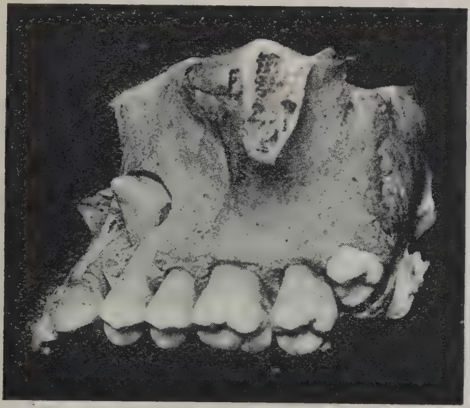

FIG. 168.—Left maxilla with the canine erupting in an upward direction.

The positions assumed by the canine in cases of this kind undoubtedly follow a definite law, and the discovery of that law would mean a great advance in our knowledge of the cause of these irregularities. This variation is at times transmitted.

(ii) *The Maxillary Premolar.*—Complete displacement of the premolar is comparatively a rare irregularity. An example is shown

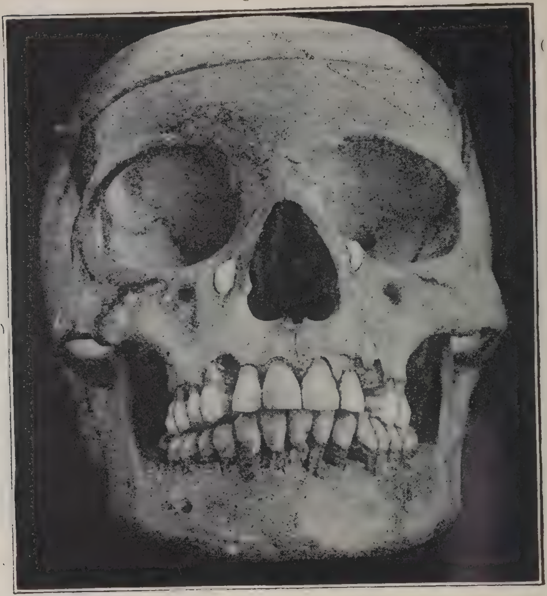

FIG. 169.—Skull showing the canines embedded in the nasal processes.

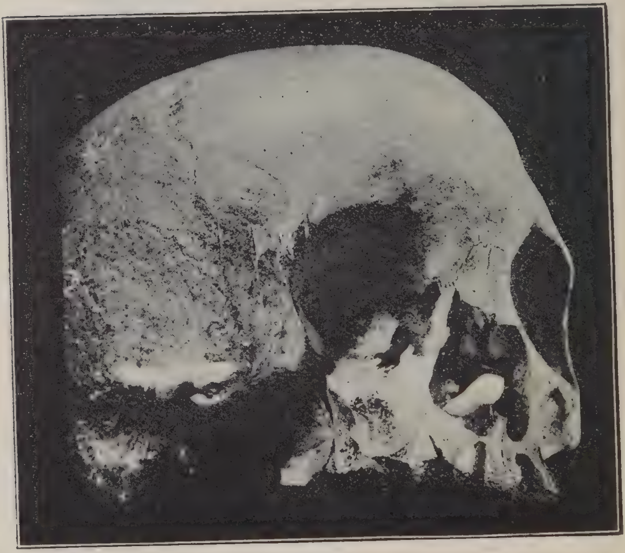

FIG. 170.—Skull of a negress with the right canine erupting in the nasal fossa. This specimen is in the Hunterian Collection.

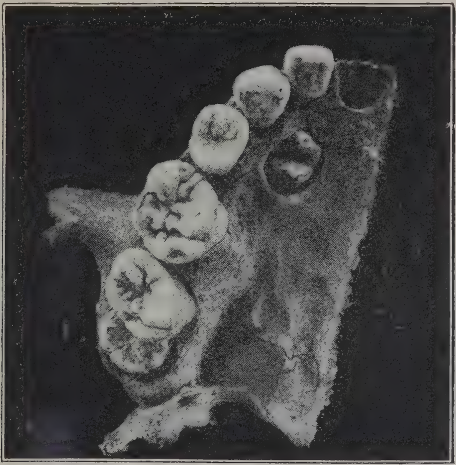

FIG. 171.—Right maxilla with the first premolar erupting in the palate.

in fig. 171, and another in fig. 172. In the latter specimen the second deciduous molar persists and is free from sepsis.

The complete displacement of a premolar is more common in monkeys than in man, and a study of the irregularity in these animals enables us to formulate a probable explanation of the cause.

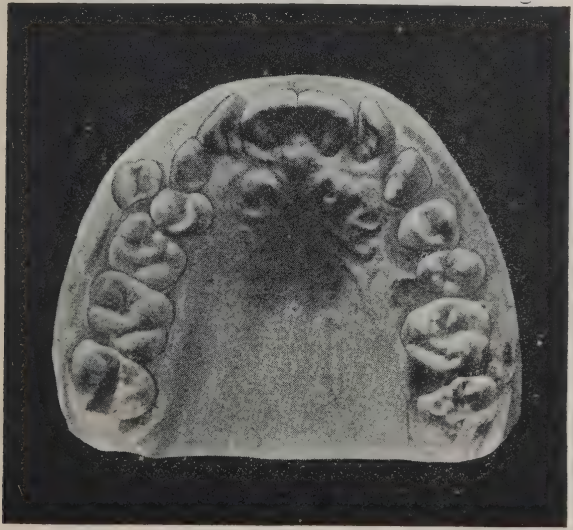

FIG. 172.—Model showing the second premolar misplaced external to the arch.

It will be noted that in monkeys the premolar, at times, develops well above the root of the deciduous molar (see fig. 173), and it can readily be understood, therefore, that if, in development, there is the slightest deviation from the normal direction the tooth may be displaced. The displacement of a premolar in man is possibly to be attributed to similar conditions, that is to say, the premolar, instead of developing within the roots of its predecessor, is formed beyond them, and has therefore a tendency to assume an abnormal position in its subsequent growth.

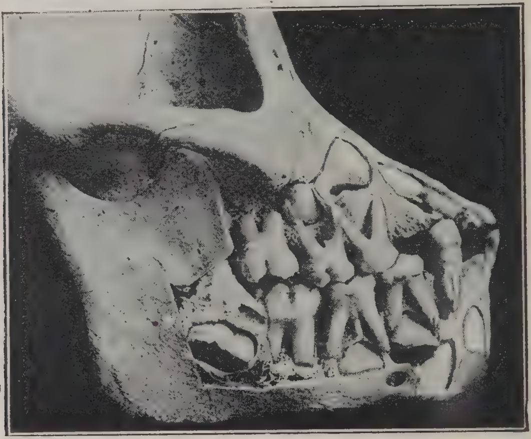

Fig. 173.—The skull of a chimpanzee to show the position of the developing second premolars.

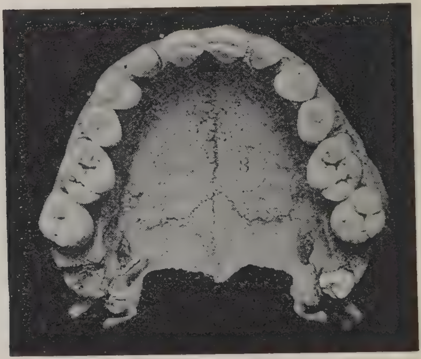

Fig. 174.—Maxillæ with the left third molar displaced backwards.

Complete rotation of the second premolar occurs, the palatal aspect being placed outwards. The fact that this abnormality is at times symmetrical suggests that it is due to an inherited cause. In the specimen (fig. 174) the second premolars have the external cusps rotated backwards.

(iii) *The Maxillary Molars.*—The maxillary third molar is frequently misplaced. This tooth may be carried away from the second molar (see fig. 174), but more often it is situated high in the tuberosity and, as growth proceeds, becomes embraced by the roots of the second molar. At times the tooth develops so high above the second molar that fusion of the roots may take place. The crowns may be tilted forwards and the roots backwards, or the tooth may be rotated, the buccal surface facing forwards. Lastly,

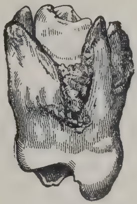

FIG. 175.[1]

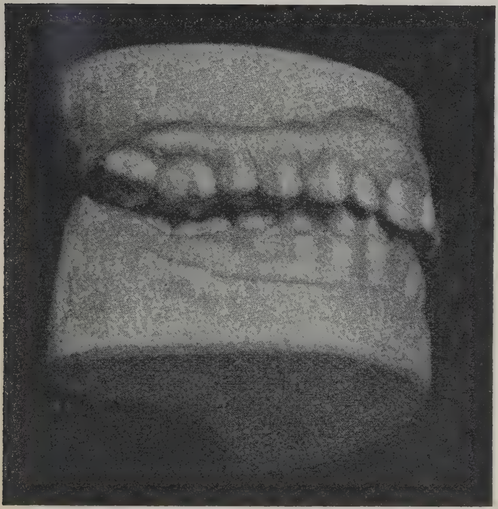

FIG. 176.—Models of a female at fourteen years, showing the maxillary premolars and molars external to the arch of the mandibular teeth.

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[1] From "A System of Dental Surgery," by C. S. Tomes and W. S. Nowell.

we get that singular condition in which the crown of the third molar lies in an inverted position within the roots of the second molar (fig. 175).

A curious but well-defined class of irregularity is shown in

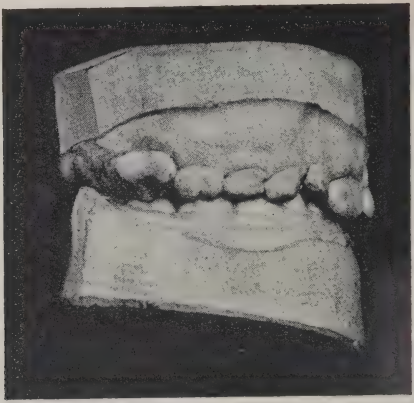

FIG. 177.—Models of the same individual taken at about seven years of age to show the occlusion of the deciduous teeth.

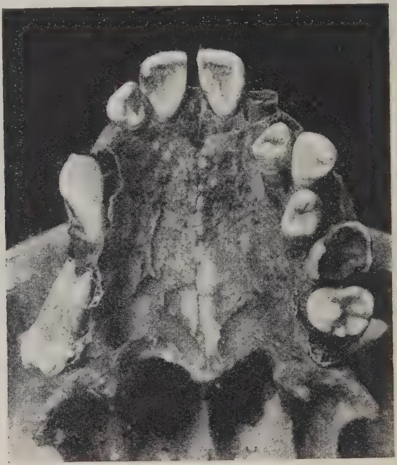

FIG. 178.—Portion of a skull showing multiple irregularities in position of the teeth.

fig. 176. The maxillary premolars and the first and second molars on the right side have erupted external to the arch of the mandibular teeth. This irregularity did not exist in the deciduous dentition, and the first sign of it was the eruption of the maxillary right first molar in the position shown in fig. 177. A similar condition is occasionally seen in the apes and monkeys.

The explanation of these cases is probably to be found in an aberration of that portion of the tooth band from which the teeth have their origin.

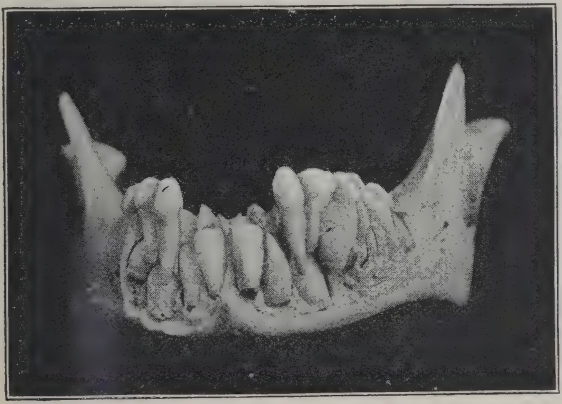

FIG. 179.—Mandible with the left second incisor rotated.

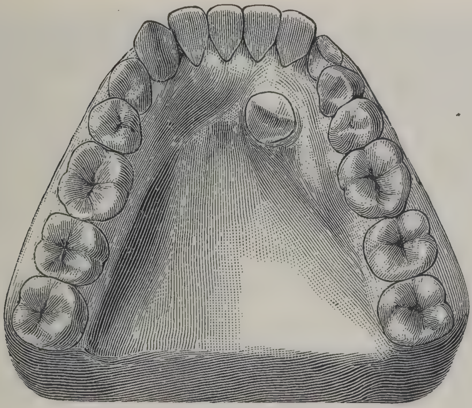

FIG. 180.—Model showing the mandibular right canine placed internal to the arch.

A remarkable specimen showing irregularity in position of several teeth is shown in fig. 178. The maxillæ and the rest of the skull are normal in character, but the teeth show an extraordinary arrangement. On one side the canine has erupted between the premolars, with the root of the deciduous canine persistent in its normal position. On the other side the canine lies obliquely across the alveolar ridge, the crown pointing forwards and slightly outwards and downwards, with the root running backwards, slightly inwards and upwards—the tooth is rotated so that the internal aspect of the crown is downwards. The premolars are missing, and there are no signs that they were ever present. The first molar lies horizontally, with the occlusal surface directly backwards and the roots forwards. It is of interest to note that there are two enamel nodules on the left second molar.

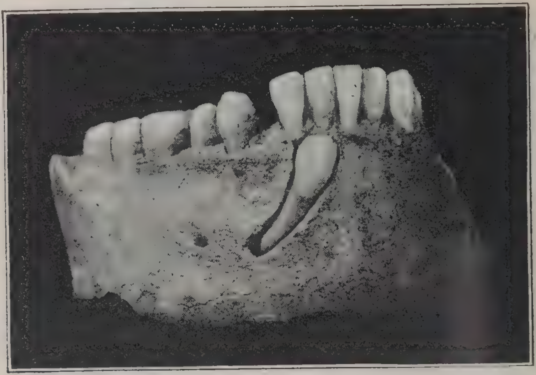

FIG. 181.—Mandible with the right canine erupting anterior to the roots of the incisors.

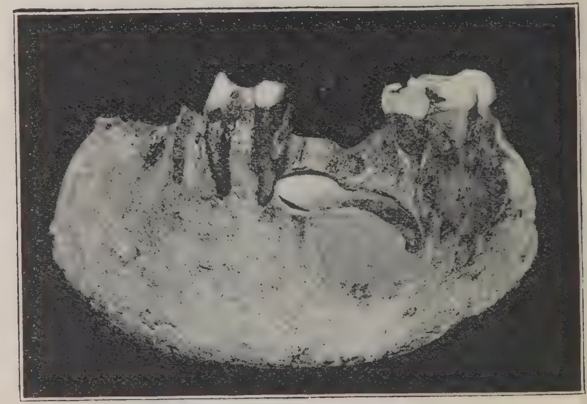

FIG. 182.—Portion of mandible with the left canine embedded in the bone.

(iv) *Mandibular Incisors.*—In well-developed arches the second incisor is at times rotated so that the distal angle looks inwards.

This irregularity should be classed as a definite inherited defect. A mandible showing this irregularity is illustrated in fig. 179, and it is interesting to note that the developing second molar is also misplaced (see fig. 185).

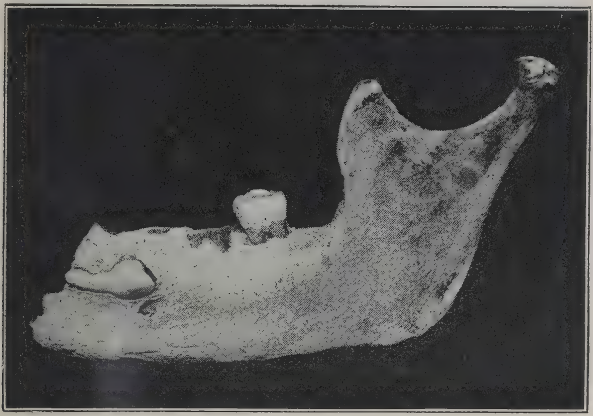

Fig. 183.—Left half of mandible with the first premolar embedded in the bone.

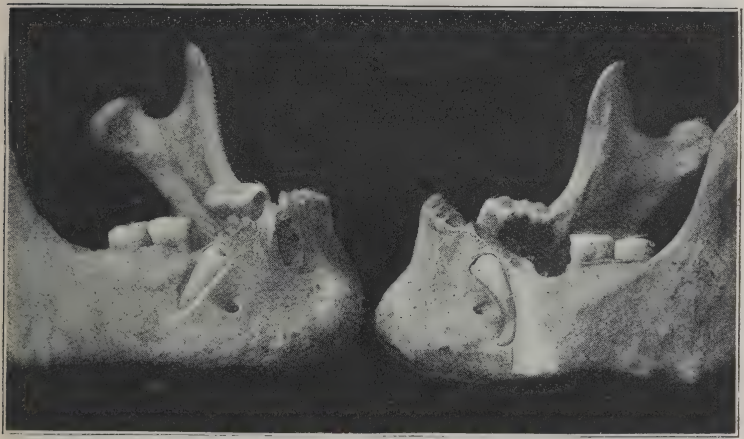

Fig. 184.—Mandible with the second premolars embedded in the bone.

(v) *Mandibular Canines.*—Although not so prone to wander as its fellow maxillary tooth, the mandibular canine shows definite variations in its position. It may erupt internal to the arch (fig. 180), or it may appear external to the arch directly in front of the incisors (fig. 181), while in other instances it may remain embedded in the bone, as in fig. 182. In one case observed the right canine erupted between the first and second incisors. In 1,000 cases examined, fourteen examples of misplaced unerupted mandibular canines were noted; in one instance the condition was associated with a misplaced maxillary left canine.

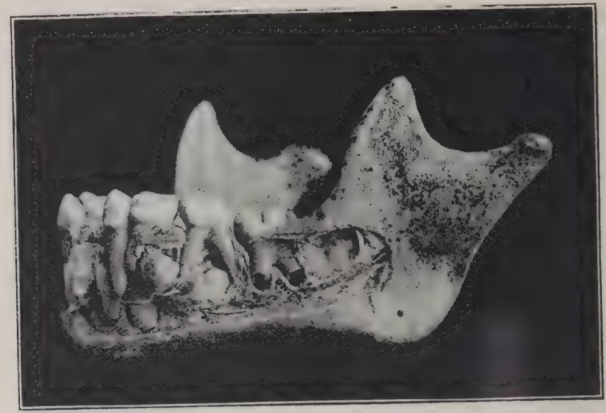

FIG. 185.—Mandible with the growing second permanent molars tilted directly inwards. This is a side view of the specimen shown in fig. 179.

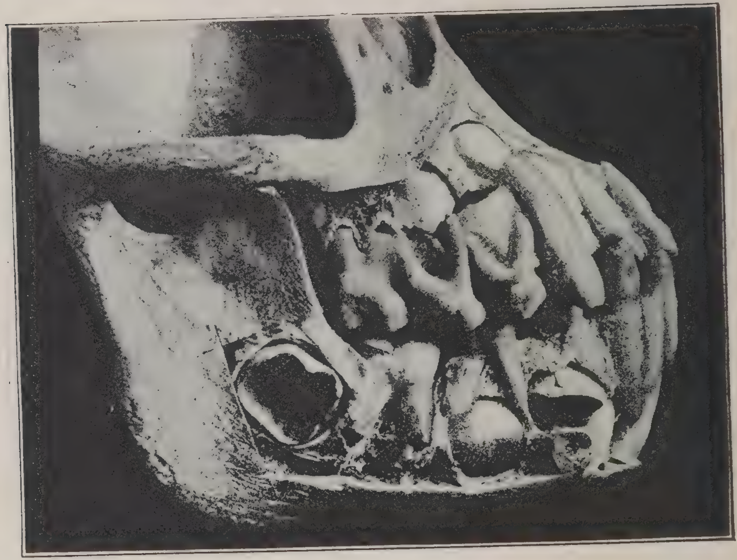

FIG. 186.—Skull and mandible of a young ape, to show the position of the developing second permanent molars.

(vi) *Mandibular Premolars.*—These teeth are at times completely displaced. In the specimen shown in fig. 183 the first premolar lies in a horizontal position embedded in the bone with the crown pointing away from the mid-line. Both the second premolars are occasionally found to be embedded in the bone (fig. 184). It will be seen from the illustration that the roots of the teeth are in close proximity to the lower border of the bone. There is ample room in the arch and the condition cannot therefore be due to impaction.

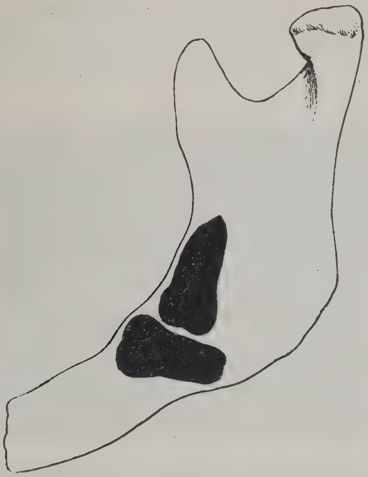

Fig. 187.

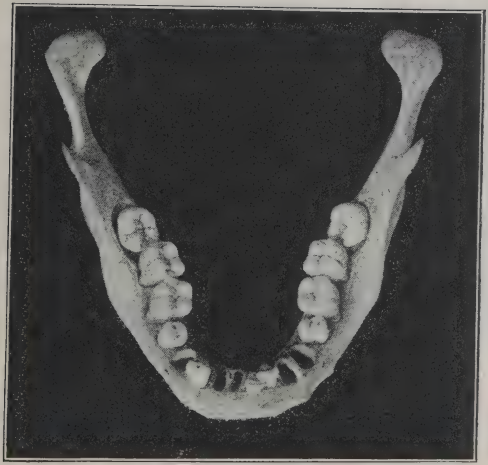

Fig. 188.—Mandible showing slight tilting of the third molars.

(vii) *Mandibular Molars.*—A curious inward tilt of the second molar, which is sometimes met with, should, it seems, be regarded as an inherited defect. In some instances the tooth occludes completely internal to the upper arch. The second molar normally develops with an inward tilt, but occasionally the tilt is more pronounced and the development takes place with the occluding surfaces directly inwards and completely internal to the upper arch. The condition is frequently seen in anthropoid apes (fig. 186). The diagram, fig. 187, taken from a radiogram, shows the second and third molars misplaced. The second molar is tilted, the crown looking forwards, while the third molar has the occlusal surface looking downwards.

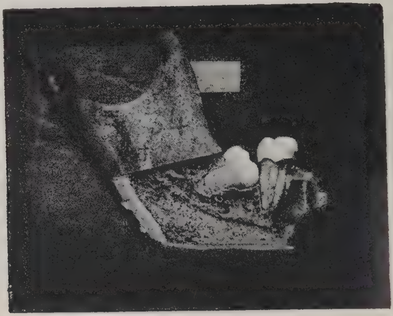

Fig. 189.[1]—Portion of mandible with the third molar impinging on the root of the second molar.

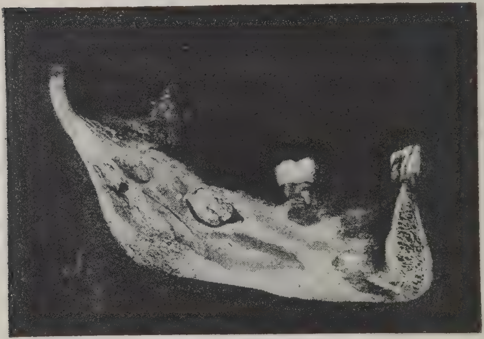

Fig. 190.[1]—Left half of a mandible with a misplaced third molar.

There are few conditions requiring treatment in practice which demand more thought and care than a misplaced mandibular third molar that is causing trouble. The tooth may be only slightly tilted forward (fig. 188); or it may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar (fig. 189). In some instances the tooth may be so placed that the occluding surface faces downwards and inwards (fig. 190). An examination of specimens exhibiting the mandibular third molar misplaced will demonstrate very clearly that the roots are to a greater or less extent covered by the ramus of the mandible. This is well shown in fig. 189. Other points brought out in this specimen are the close proximity of the root of the tooth to the mandibular canal, and the small amount of bone existing at the posterior aspect of the second molar.

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[1] From *Trans. Odonto. Soc.*

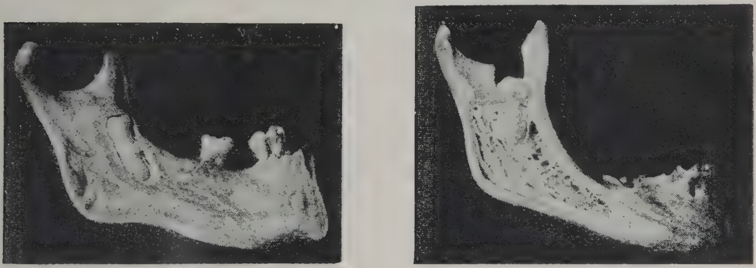

Fig. 191.[1]—Mandible with the third molars situated in the rami.

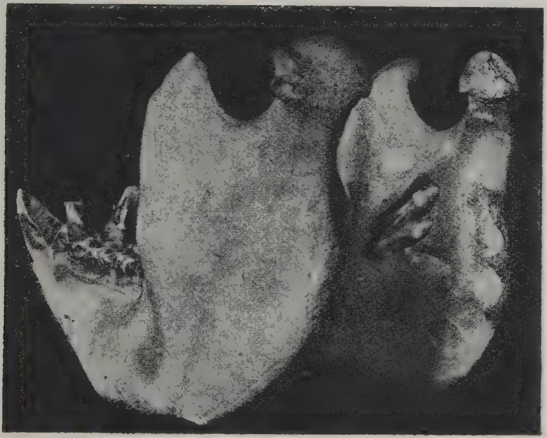

Fig. 192.[1]

By far the most interesting specimen of misplaced third molars is that shown in fig. 191. The right third molar is situated in the centre of the upper part of the ramus. The tooth is placed vertically, the crown being but little below the sigmoid notch. The left third molar is also misplaced, and rests in the anterior portion of the ramus. Both teeth, as might be expected, lie above the mandibular canal.

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[1] From *Trans. Odonto. Soc.*

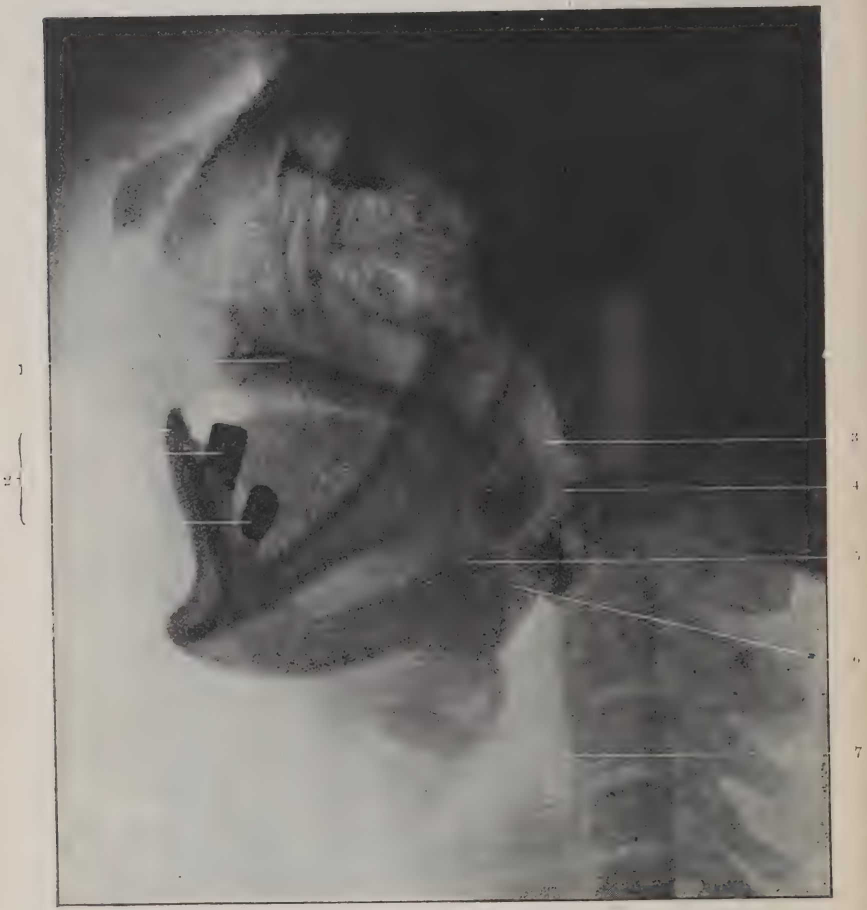

FIG. 193.[1]—(1) Hard palate; (2) teeth and crowns in mandible; (3) sigmoid notch; (4) third molar; (5) sinus leading from mouth; (6) mandibular canal; (7) trachea.

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[1] From *Brit. Dent. Journ.*

The specimen shown in fig. 192 seems to throw some light upon the foregoing pathological treasure. The specimen represents the mandible of a gorilla with two cone-shaped teeth embedded in the right ramus; one of these teeth is triple-rooted and one single-rooted. The full number of premolars and molars are in place in the mandible, and the cone-shaped teeth must therefore be regarded as supernumerary teeth. It will also be noticed that they lie above the mandibular canal. In this case there has been an abnormal prolongation backwards of the "tooth band," and it is probable that the displacement of third molars in many cases is due to the same cause.

J. J. Andrew[1] has recorded a case in which the mandibular left third molar was misplaced high up in the ramus, but with the apex towards the sigmoid notch (see fig. 193). In this patient, a woman aged about 55, suppuration had occurred in connection with the tooth, necessitating its removal. "An obtuse-angled incision was made along the posterior border of the ramus, and the angle of the jaw and the masseter temporarily displaced; the bone just below the sigmoid notch was removed by means of a trephine and the tooth exposed and removed."

In the case shown in fig. 194 the third molar erupted at the angle of the jaw.

Misplaced mandibular third molars are met with in monkeys and apes. It is a fairly common irregularity in man, thirty examples being seen in one thousand patients, the left tooth being misplaced in twenty-four cases and the right tooth in ten.

(γ) *Abnormalities due to Variation of Jaw Development in Relation to the Size of the Teeth*

"Individual variability is a general character of all common and widespread species of animals or plants; and, further, this variability extends, so far as we know, to every part and organ, whether external or internal, as well as to every mental faculty. Yet more important is the fact that each part or organ varies to a considerable extent independently of other parts" (Wallace).

In this section it is proposed to consider how far this phenomenon of variability is responsible for general irregularity of the teeth. If series of different species of animals be examined it will readily be observed that a diminution in the length of the jaws is not accompanied by a corresponding diminution in the size of the teeth, with the result that in many species the teeth are arranged in a slightly irregular or crowded manner. In animals under domestication this variation in the length of jaws without corresponding adjustment in the size of the teeth is still more marked, particularly in the different breeds of dogs. It may be said that as a rule the shorter the jaw, the greater the tendency to crowding of the teeth.

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[1] *Brit. Dent. Journ.*, vol. xxx, p. 289.

As an illustration four breeds of dogs will be compared, namely, the Borzois hound, the Greyhound, the Aberdeen terrier, and the Bulldog. The length of the jaws of these animals decreases in the order shown. The maxillæ of the Borzois hound (fig. 195) are very long and the anterior cheek teeth are well separated; in the Greyhound (fig. 196) the maxillæ are shorter, and there are spaces between the anterior cheek teeth, but these teeth are not so widely separated as in the Borzois hound; in the Aberdeen terrier (fig. 197), with its still shorter maxillæ, the premolar teeth are in contact, and there is insufficient room for the fourth premolar; while in the Bull-dog (fig. 198), with its comparatively short maxillæ, the premolars and molars are arranged in an extremely crowded manner.

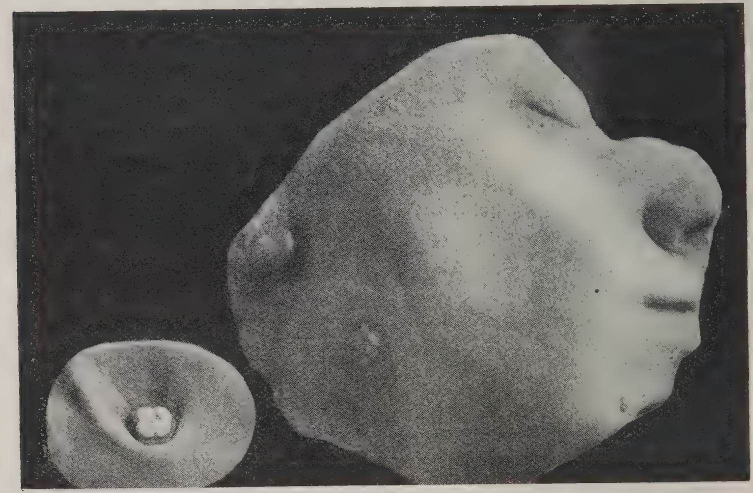

FIG. 194.

Man is no exception to this law of variation, and with the progress of civilization the reduction in the size of the jaw out of proportion to the reduction in the size of the teeth has been marked.

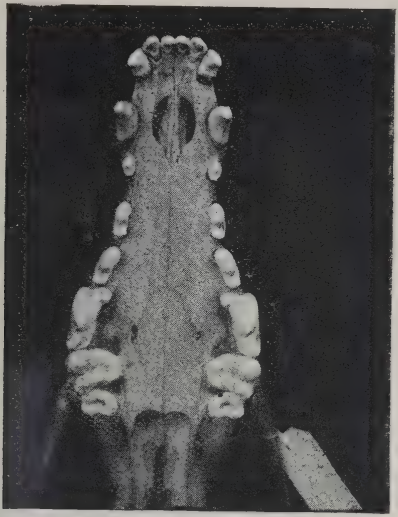

Fig. 195.—Palatal view of a Borzois hound.
From the *Dental Record.*

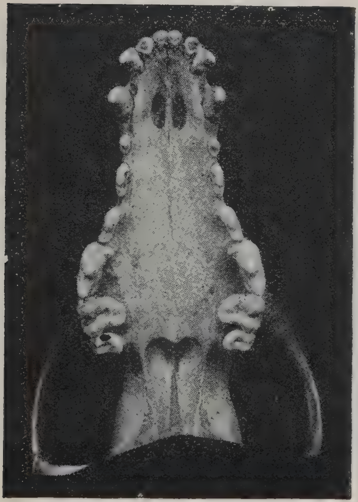

Fig. 196.—Palatal view of a greyhound.
From the *Dental Record.*

Talbot,[1] who has collected a mass of statistics relating to irregularities, affirms that the early Britons possessed maxillæ varying in their lateral diameters from 2·12 to 2·62 in., whilst in modern Englishmen the maxillæ vary from 1·88 to 2·44 in., the

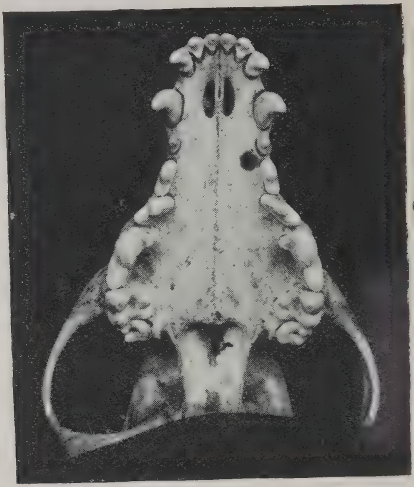

FIG. 197.—Palatal view of an Aberdeen terrier.
From the *Dental Record*.

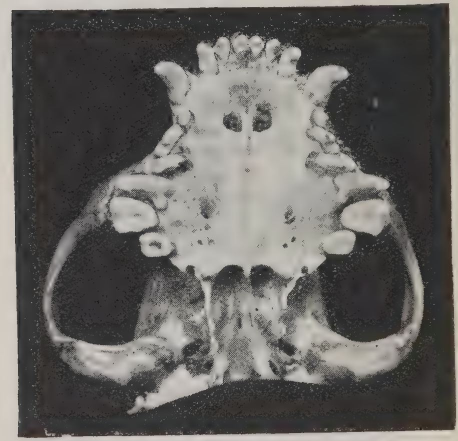

FIG. 198.—Palatal view of a bull-dog.
From the *Dental Record*.

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[1] "The Etiology of Osseous Deformities of the Head, Face, Jaws, and Teeth," Third Edition, p. 67.

minimum diameter having thus decreased more than the maximum; and that a comparison of the maxillæ of ancient Romans with modern inhabitants of Southern Italy gives a similar result. From these data he infers that the size of the jaws has diminished in the inhabitants of England and Italy, but it is not quite clear that these comparisons have any etiological significance seeing that modern Englishmen are only to a very small degree, if at all, descendants of the ancient Britons; and similarly, the present inhabitants of Southern Italy have but little claim to direct descent from the ancient Romans.

There is, however, a general consensus of opinion in favour of the view that the jaws of modern races are decreasing in size, and the teeth also, though in a lesser degree. It is interesting to note that it has been possible to trace a diminution in the size of the teeth in prehistoric times. W. Wright[1] has found in the Neolithic and Bronze ages the average length of the molar was greater than it was later on in the early Iron age.

The cause of the progressive diminution in the size of the jaws has not yet been clearly demonstrated, but, in view of all the ascertained facts bearing on the subject, the change would appear to be attributable in a great measure to the influence of civilization, and more particularly to diet and to the manner in which food is prepared. Sim Wallace, who has closely studied the subject, considers that the diminution is not due to heredity, but is "a characteristic developed in each generation as the result of the action of the environment." Under present day conditions the character of the foodstuffs is responsible for insufficient mastication, and thus by the "action of environment" the jaws are deprived of the full stimulus which is essential for their complete development.

(δ) *Defects of the Maxillary Bones and Associated Parts*

Under this heading is included the irregularity of the first incisors where the *frænum of the lip*, instead of blending with the mucoperiosteum on the anterior aspect of the alveolar process, is continued between the incisors and blends with the tissues in the region of the anterior palatine foramen. In these circumstances the frænum presses on the teeth with every movement of the lip and the pressure tends to separate the teeth. A persistent labial frænum of the lower lip occurs, though much less frequently, and is at times transmitted from parent to offspring.

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[1] *Journ. Brit. Dental Assoc.*, February 16, 1903.

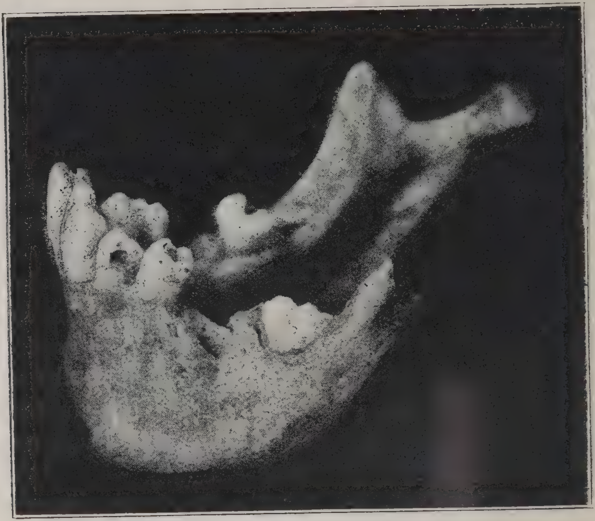

FIG 199.—Specimen showing arrested growth of the left half of the mandible.

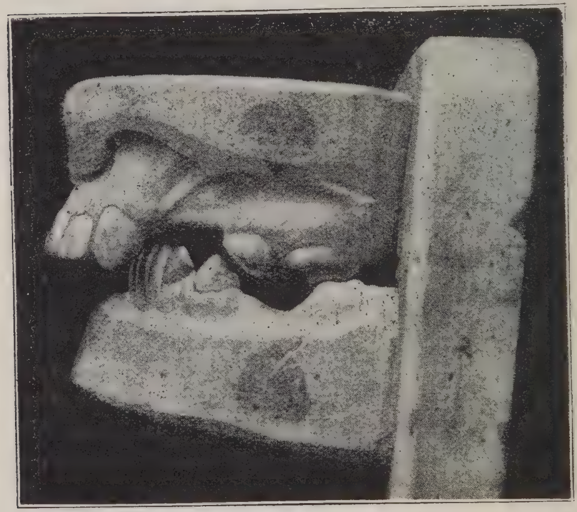

FIG. 200.—Models of a patient in which the left half of the mandible was arrested in its growth.

(2) ABNORMALITIES DUE TO ACQUIRED CAUSES

(*a*) ANTE-NATAL OR INTRA-UTERINE ACQUIREMENT

In cases of defective development of the maxilla or mandible the teeth present marked abnormalities of position. In cleft palate involving the premaxilla the incisors and canine are misplaced, while partial arrest in the growth of the mandible naturally results in considerable disturbance of the relation of the dental arches to one another. A case of arrest of growth of the left half of a mandible is shown in fig. 199, and in fig. 200 the models of a case in which a similar condition was present.

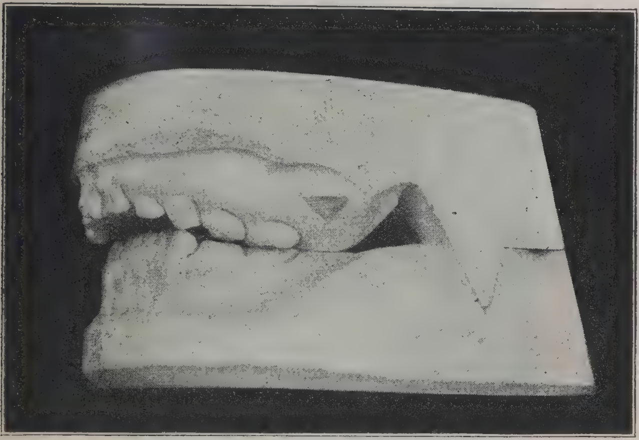

FIG. 201.—**Models of a child, showing the results of injury of the mandible at birth.**

It may seem more appropriate that irregularities associated with defective development of the maxillary bones should be grouped under "inherited defects." It is, however, more in keeping with the general trend of current opinion to regard them as due to intra-uterine processes.

(β) PARTURIENT, ACQUIRED AT THE TIME OF BIRTH BEFORE COMPLETE SEPARATION OF THE INDIVIDUAL FROM THE MATERNAL ORGANISM

There is ground for believing that a few abnormalities of the teeth may be traced to injury at birth. Fig. 201 illustrates the case of a boy six years of age who came under the care of G. Berwick. The defective growth of the mandible, due to an injury at birth, resulted in marked prominence of the upper teeth. The labour was very difficult and it was necessary to use forceps, which injured the face on the right side from the angle of the jaws to the chin.

It seems quite possible that prolonged labour, especially in certain presentations, may lead to abnormality in position of the teeth.

The asymmetry of the dental arch so often seen is probably the effect of excessive moulding of the skull during birth. An example is shown in fig. 202. It will be noticed that the left side of the face is flattened and that the left occipital region is squeezed outwards. In this case the labour was prolonged but no instrument was used. According to the father's statement "the child was born with the head as it is, but the doctor said it would come straight in time." The asymmetry of the mandibular arch is shown in a drawing on mm. paper from a model of the mouth (fig. 203).

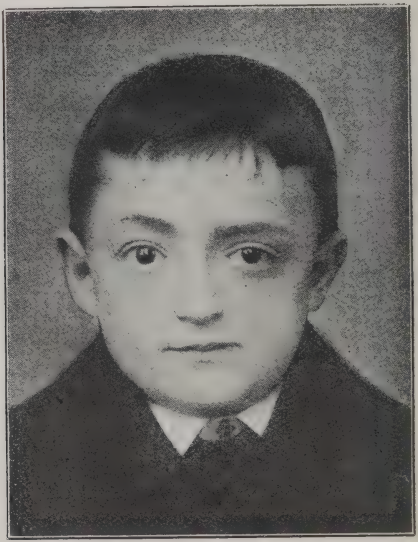

Fig. 202.—Photograph of a child with extreme asymmetry of the face.

The models shown in fig. 204 are those of a boy about five years of age. The parents are healthy, and possess normal jaws. The child was breast-fed and there was no suspicion of adenoids. The width of the arch is 22·76 mm. across the inter-canine region and 29·65 mm. across the second molar region. These dimensions are

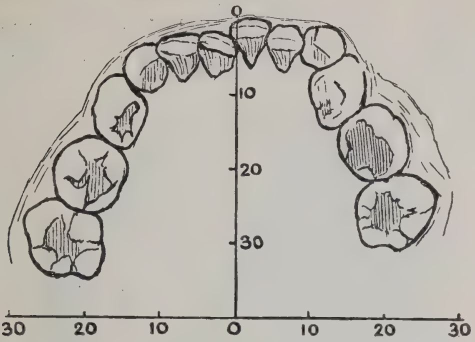

FIG. 203.—The mandibular teeth of the case shown in fig. 202.

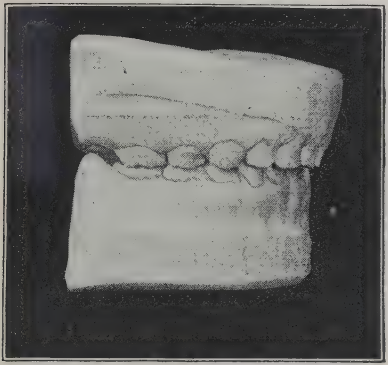

FIG. 204.—Models showing abnormal occlusion of the teeth.

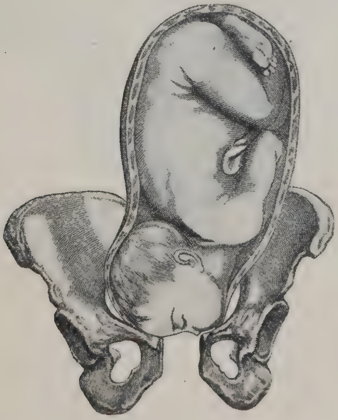

FIG. 205.—Diagram of a face presentation.

above the average. The occlusion is abnormal, the mandibular teeth being posterior to their normal relation to the maxillary teeth. The cause of this mal-occlusion was difficult to account for until it was ascertained that the child was an example of face presentation and that the labour had been prolonged. Before complete extention occurs in face presentation the head passes through the brow position and the diameter of engagement is the mento-vertical, i.e.,

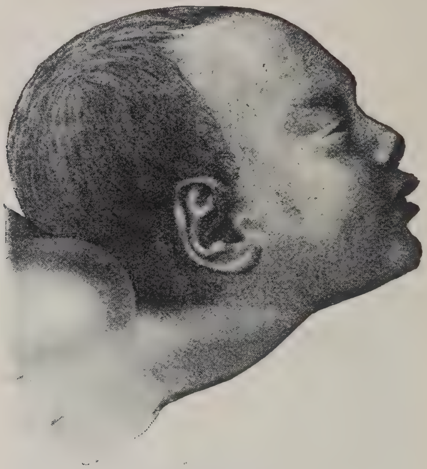

FIG. 206.
Shows the head before moulding.
From Edgar's "Practice of Obstetrics."

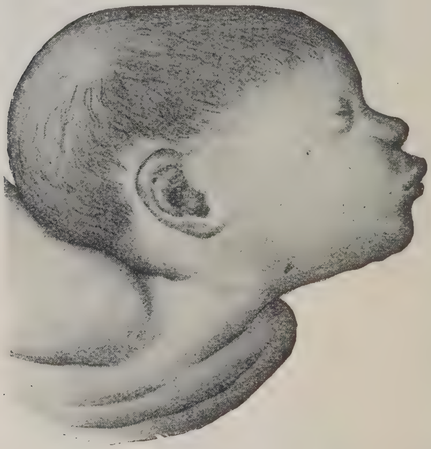

FIG. 207.—The head after moulding in a case of face presentation.
From Edgar's "Practice of Obstetrics."

from the point of the chin to the most distant point of the vertex (see fig. 205). Whilst this position is maintained the jaw must be compressed. As fuller extension occurs the occiput is compressed against the spine and the chin slips up, the diameter of engagement then being the cervico-vertical and cervico-bregmatic; at this stage there is no undue pressure on the chin. It seems quite possible, therefore, that if labour is prolonged during the mento-vertical stage permanent injury may be done to the mandible.

Figs. 206 and 207 are reproduced from "Edgar's Practice of Obstetrics" and show the face before and after moulding. The appearance of the face after moulding suggests some retraction of the mandible.

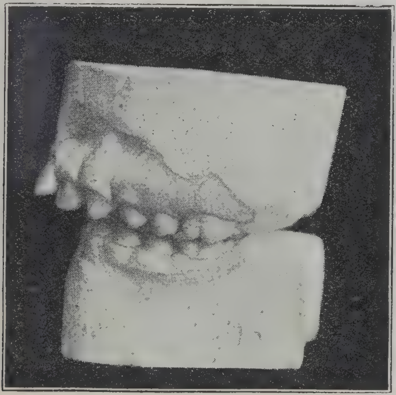

Fig. 208.—Models of a girl at eleven years with abnormal occlusion of the teeth associated with a difficult face presentation.

Another of these cases is shown in fig. 208. The anterior maxillary teeth are unduly prominent. The child was breast-fed and there was no trace of adenoids. The occlusion is abnormal, the mandibular teeth being posterior to their normal relation with the maxillary teeth. In this case the labour was difficult and prolonged. The jaws of both parents are well developed, and the remaining children in the family—four in number—have well-developed arches and normal occlusions.

The facts quoted above are sufficiently suggestive to warrant a full inquiry into a possible relationship between difficult labour and irregularities of the teeth.

(γ) Post-natal or Acquired after Birth

The majority of irregularities fall under this heading, and can be traced to (*a*) mechanical causes inducing "trauma," (*b*) the effects of septic processes in connection with the teeth, (*c*) morbid conditions leading to diminished or excessive growth of the maxillæ or mandible.

(i) Mechanical Causes

The mechanical causes leading to deformities of the dental arch can be grouped under two headings:—

(*a*) Direct injury of the teeth or jaws.
(*b*) Abnormal conditions of the surrounding soft tissues.

(*a*) *Direct Injury of the Teeth or Jaws*

(1) *The Premature Removal of Teeth.*—With the removal of a tooth there is a tendency for the approximal teeth to come together. In the maxilla, this movement is brought about by the muscular pressure of the lips, the tension of the cheeks and the forward movement of the permanent molars; in the mandible, by the action of the tongue and the tilting movement of the permanent molars. The extent of the deformity depends on the tooth removed, the time of removal, the occlusion of the teeth, and the development of the bones.

The following examples will illustrate these points. If a maxillary second deciduous molar is removed after the eruption of the first permanent molar, the latter tooth will tend to move forwards, and the first deciduous molar backwards. The extent of the movement of the permanent molar will vary according to the degree of interference with the growth of the bone in the molar region. If there has been normal growth, and if the first molar is in good occlusion with the mandibular tooth (i.e., interdigitation of the cusps is well marked) the amount of forward movement will be slight. If, on the other hand, there has been interference with the growth of bone, the tendency of the permanent molar to forward movement will be marked, even though the occlusion may be good. The tendency of the first deciduous molar to move backwards is brought about by the muscular pressure of the lips, but the lips will not exert much influence if the occlusion with the mandibular teeth is good.

If a second deciduous molar is removed before the permanent molar has erupted, the forward movement of the latter will be marked, and in some cases it will encroach upon the whole space previously occupied by the deciduous tooth.

If a deciduous canine is removed at an early age, the closing of the space is mainly due to a spreading movement of the incisors, brought about in the maxillary arch by the lips and in the mandibular arch by the tongue. The deciduous molar may also move forwards, but this will depend mainly upon the forward pressure of the permanent molars.

If the mandibular first permanent molars have been removed before the eruption of the second premolars, the latter occasionally erupt far back in the arch, as shown in fig. 209.

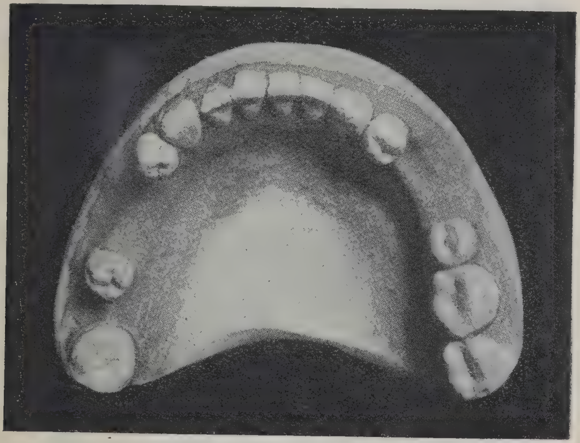

Fig. 209.—Model showing movement backwards of the mandibular second premolars following early extraction of the first permanent molars.

(2) *Caries of the Teeth.*—Loss of tissue from caries on the approximal surfaces allows the teeth to close on one another. A forward movement of the permanent molars often occurs from this cause.

(3) *Septic Processes in connection with the Teeth.*—The presence of septic teeth is a common cause of irregularities. Under normal conditions the loss of the deciduous teeth is due to absorption of their roots. When the tissue of the deciduous tooth has been robbed of nutrition in consequence of injury to the pulp, absorption takes place slowly and is often completely arrested. Such teeth obstruct the movement of the erupting tooth, deflect it from its course, and so cause it to erupt in an irregular position.

(4) *Fracture of the Jaw* in children is frequently followed by

irregularity in the position of the permanent teeth located in the region of the fracture.

(5) *Operations for Cleft Palate.*—Operations for the treatment of cleft palate are at times followed by considerable disorganization of the dental arch (fig. 210), which necessitates free extraction and the adoption of dentures to provide a satisfactory masticating surface. A. T. Pitts[1] states that there is a difference in the type of deformity following the method of operation. In the "flap" operation the deformity is chiefly limited to the side from which the flap is taken, the arch on the side opposite to the flap being usually normal; in the Langenbeck operation where tension is exerted on both sides of the jaw by the operation there is a bilateral contraction of the arch, but the degree of deformity is much less than in the flap operation.

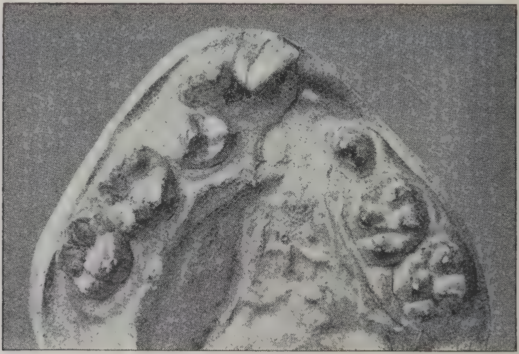

Fig. 210.—Model showing deformity of the arch following the flap operation for cleft palate. (From *Brit. Dent. Journ.*)

(*b*) *Abnormal Conditions of the Surrounding Soft Tissues*

(1) *Habits.*—Certain habits are contracted by children, such as finger-sucking and lip-sucking, which, if persisted in, will produce deformed arches. In the habit of sucking the thumb or finger, the palmar surface of the thumb is placed against the palatal surface of the first incisors, the mandibular teeth being closed on the dorsal aspect. The pressure exerted causes the maxillary first incisors to protrude, so that the lower lip passes behind them and aggravates

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[1] *Brit. Dent. Journ.*, May 1, 1922.

the protrusion when the mouth is at rest. At times the thumb or finger is inserted between the teeth in such a manner as to cause the teeth to impinge on the lateral surfaces. Under such conditions, the maxillary incisors and canines are forced outwards and frequently upwards, producing a type of irregularity known as "open bite." Sucking of the lower lip may force the lower teeth backwards and the upper teeth outwards. I have seen a child three and a half years of age with the lower incisors forced backwards over the tongue, these teeth being three-quarters of an inch behind the

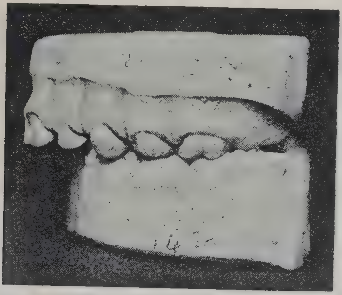

FIG. 211.[1]

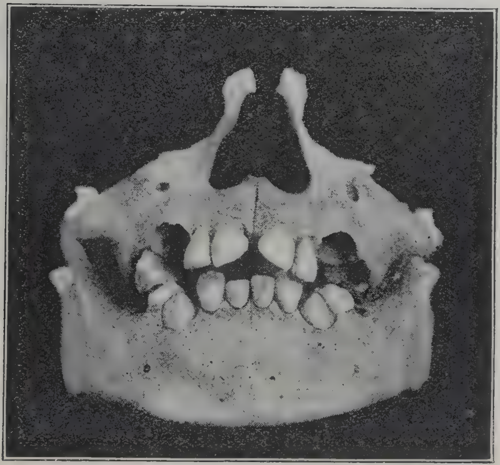

FIG. 212.—Maxillæ and mandible showing protrusion of the maxillary incisors as seen in children addicted to the habit of thumb-sucking.

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[1] From *Proc. Roy. Soc. Med.*

upper incisors. Another habit acquired consists in forcing the tongue over the tips of the lower teeth and against the upper incisors, causing protrusion of the latter teeth.

The prolonged and persistent use of the "baby comforter," or "dummy," is a fruitful source of dental deformity. Fig. 211, the models of a child aged five, illustrates the protrusion of the maxillary arch from this cause. The protrusion was well marked when the child was about eighteen months old.

Careful inquiry into the use of the "dummy" would seem to show that, if its use is persisted in, deformity of the maxillary dental arch will almost certainly result. The extent of the deformity will depend on the frequency with which the "dummy" is used, the period over which its use extends, and the presence or absence of rickets.

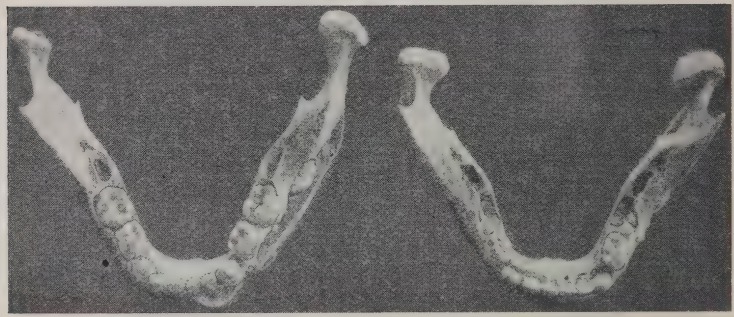

Fig. 213.

Normal mandible.

Abnormal mandible, showing bend in the neck of the condyle.

The maxillæ and mandible illustrated in fig. 212 show the type of deformity usually seen in children addicted to thumb-sucking. The maxillary incisors project, while the arch of the mandibular incisors is flattened. There is reason to think that in these cases the force on the incisor teeth in the backward direction is resisted at the articulation, with the result that the neck of the condyle takes an inward direction, as shown in fig. 213.

(2) *Cicatrices.*—If the soft tissues in the neighbourhood of the jaws have been injured the contraction of the cicatrix may divert the teeth from their normal positions. A case of protrusion of the lower incisors which followed an extensive burn of the soft tissues of the neck is shown in fig. 214.

(ii) CAUSES LEADING TO ABNORMAL GROWTH OF THE MAXILLA OR MANDIBLE

By far the greatest number of cases of irregularities of the teeth are the outcome of a diminished growth of the maxilla and the mandible. As regards the most suitable treatment of these cases there is considerable diversity of opinion, which will probably disappear as soon as the pathology of these cases has been established. Before discussing possible causes, it may be advantageous to refer to **the relation of the maxillary-premaxillary suture to irregularities of the teeth.**

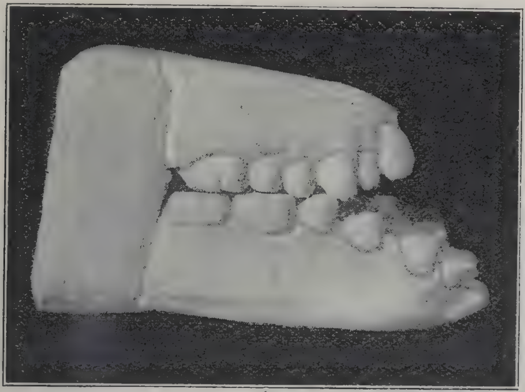

FIG. 214.—Models showing displacement of the mandibular teeth, the result of contraction of a cicatrix (Tomes).

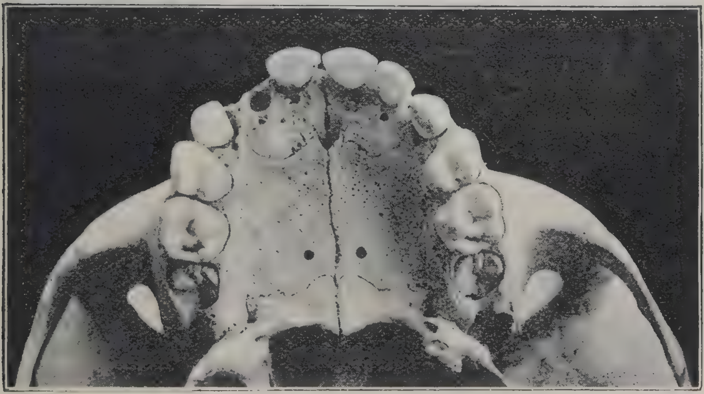

FIG. 215.—Maxillæ of a child about three years of age.

An examination of skulls of children suggests that growth of bone at the maxillary-premaxillary suture continues until the eruption of the second dentition is well advanced, and there is reason to believe that the premature closing of the suture is causally related to a crowded arrangement of the incisor teeth.

In the infant this suture is well marked and runs posterior to the foramina leading to the permanent incisor teeth and ends near the margin of the canine socket. Later on the suture tends to be separated by an increasing interval from the incisors. The outer portion of the suture fills in first, the inner portion being often well marked in the skulls of children of from twelve to sixteen years of age.

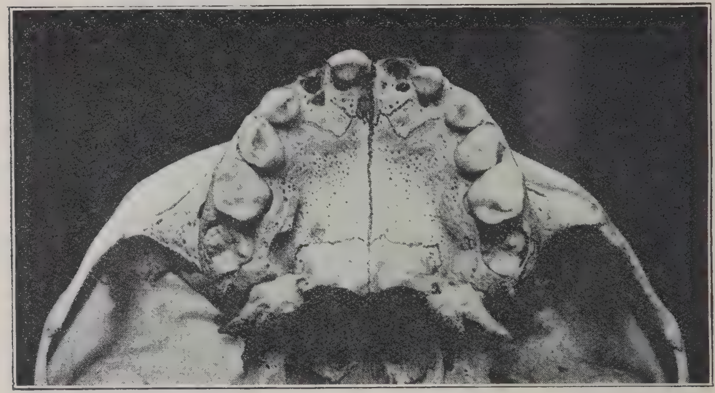

Fig. 216.—Maxillæ of a child aged four years six months. Each premaxilla is developed from two centres.

Palates with well-marked sutures are as a rule wider than those where the suture is ill-defined. A comparison of the inter-canine and inter-second deciduous molar widths of forty-seven specimens gives the following figures:—

	Inter-canine	Inter-second molar
Well-defined sutures (32 specimens) ...	22·5 mm. ...	27·8 mm.
Ill-defined sutures (15 specimens) ...	21·0 mm. ...	26·8 mm.

It will be noted that the difference in the width of the arches is greater between the canines than the molars.

Maxillæ showing well-defined sutures are shown in figs. 215 and 216. In both these specimens the dental arches are well formed and the teeth are not crowded.

In the maxillæ (fig. 217) from a child aged three years two months the outer two-thirds of the sutures are closed, the teeth are curved inwards and are crowded. The canine and molar widths are 19 mm. and 23·5 mm., the normal average being 22·5 mm. and 27·8 mm. The conclusion to be drawn from the examination of dried specimens is that early closure of the suture and crowding of the anterior teeth are definitely related.[1]

(a) *Acquired Conditions interfering with the Growth of the Jaws*

(1) The Method of Feeding in Infancy.—There is ample testimony that the method of infant feeding influences the shape of the palate and dental arch.

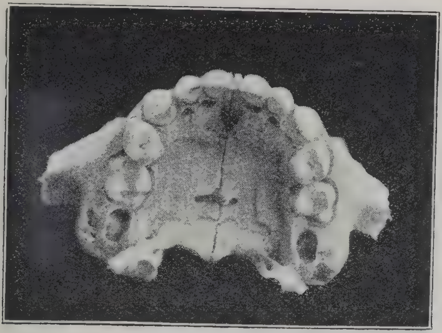

FIG. 217.—Maxillæ of a child aged three years two months with crowded incisors associated with partially closed sutures.

A series of measurements made of the arches of children free from adenoids gave the results shown below:—

	Width between the first permanent molars A	Width between the first deciduous molars or first premolars B
Breast-fed	34·85 mm.	26·31 mm.
Hand-fed	34·1 ,, ...	25·61 ,,

The width (A) between the first permanent molars was measured from the gum margins immediately in line with the fissure on the palatine aspect of the teeth. The width (B) between the first deciduous molars or first premolars was measured from the gum margins at the point corresponding to the centre of the palatine aspect. The same plan is followed in the measurements shown on pp. 155 and 158.

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[1] A fuller account of the relation of the maxillary-premaxillary suture to irregularities in position of the teeth will be found in the *Dental Record*, February, 1914.

The figures recorded above show that breast-fed children have slightly broader arches than those fed by artificial methods. The measurements given relate to patients in private practice; figures gathered from patients in hospital show a greater difference between the arches of breast-fed and hand-fed children.

To ascertain the comparative breadth to the height of the palate plaster casts were made of the patients, and these were divided at a point corresponding to the middle of the second deciduous molar and second premolar. Tracings on paper were then made and a line drawn between the gingival edges, and from the centre of this base a line was drawn at right angles to ascertain the height. In the case of breast-fed children the breadth of the palate averaged 2·62 times the height, in the hand-fed children 2·52 times the height.

In hand-fed children there is a greater tendency to abnormal occlusion than in breast-fed children.

It seems quite feasible that this variation in the palates and arches of breast- and hand-fed children is due to the difference between the action on the palate of the teat and the nipple. An infant, when at the breast, takes not only the nipple, but a considerable portion of the areola into the mouth, and the tongue is often seen protruding over the lower lip. In the act of feeding the mandible is first slightly depressed and then raised so as to squeeze the breast against the palate, and the milk so expelled is then swallowed. The jaws then separate to admit more milk into the flaccid apex of the breast, and the process is repeated. The general effect of this action is to bring the muscular tissue about the jaws into activity, and to spread the palate.

With the modern-shaped bottle the child is held on the left arm and the bottle is kept at such an angle that the milk passes into the teat; the mandible then exerts a squeezing action and the milk, passing into the mouth, is swallowed. If the bottle is used correctly, very little sucking is performed by the child, the whole act simulating that of the child at the breast; but there is this difference, the teat is not so tough and resistant as the breast, and the pad in the mouth exerts less pressure on the anterior part of the palate; still further, the backward force of the breast upon the anterior part of the arch is absent.

The ideal teat has yet to be designed, but it seems obviously desirable that so far as possible the natural action of the nipple should be reproduced, and to this end teats for bottles should be made flat and broad at the base, a little longer than those at present used and of a tougher character. Now that so many children are hand-fed the matter is of considerable importance.

The modern feeding-bottle is, however, a great improvement on the old tube feeding-bottle. The teat of the old tube feeding-bottle is of a narrow tube-like type from 1 to 1½ inches in length. In taking the milk from this bottle, the tongue is close around the teat and the act of suction is brought into play. The mandible is not brought into use, and the whole action of the muscular tissue of the cheeks is towards the median line, and not away from it as it is when the child is breast-fed. The action tends to narrow the palate instead of spreading it. The average measurements of the arches of forty-one patients who had used the tube bottle were as follows:—

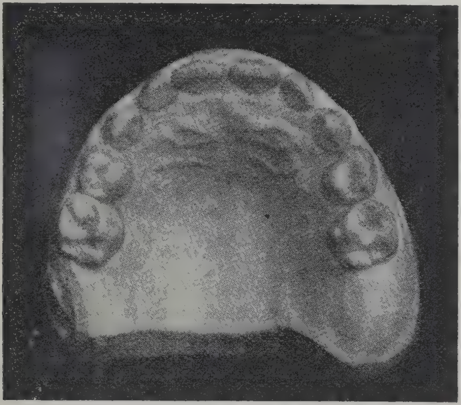

FIG. 218.—The model of a child that was breast-fed and had not suffered from adenoids.

A		B
32·14 mm.	... ...	23·05 mm.

These figures, compared with those of hand-fed by modern feeding-bottles, show a marked diminution in width, especially in the premolar region.

(2) The Effects of Disease on the Growth of the Jaws. (i) ADENOIDS.—Nasal obstruction arising from the *presence of adenoids* greatly influences the growth of the maxilla, the effect produced depending on the period of onset and the persistence of the adenoids. The earlier the age at which the adenoids appear the more marked will be the effect on the teeth and palate and the longer they persist the greater will be the damage.

The Character of the Deformity.—If the mouth of a child of about four years of age that was breast-fed and that had not had adenoids be examined, the teeth will be found to form a regular arch, with the anterior teeth separated by slight spaces. The vault of the palate in section across the first deciduous molars will be oval-shaped, and, in longitudinal section, will rise with a gentle incline from behind the front teeth to the vault (see fig. 218).

In a child that has suffered or is suffering from adenoids, the teeth will be crowded and the muco-periosteum of the palate will present a somewhat puckered appearance (fig. 219); the vault, in transverse section, will be dome-shaped, and, in longitudinal section, will rise somewhat abruptly from the posterior aspect of the incisors, the palate will have the appearance of having been pushed up towards the front, and in some cases the deciduous molars will occlude too far forward.

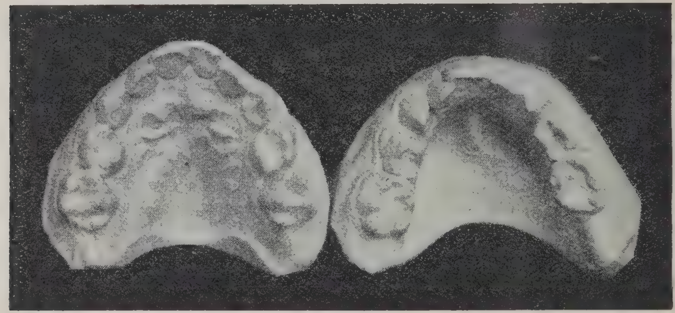

Fig. 219.—Models of a child, aged five years and seven months, that had suffered from adenoids from the age of two years. The puckered appearance of the muco-periosteum covering the hard palate and the crowding of the teeth are well shown.

If the adenoids have not been severe and are removed before the age of six, their effect on the permanent teeth will be to crowd the upper incisors, the disturbance ranging from a slight tilt of the second incisors to an irregularity involving the four anterior teeth, but the first molar will erupt in good position and, provided that the deciduous molars are retained for the normal period, the premolars will erupt in normal occlusion. The canines, when in place, will show a slight slope of the roots towards the median line. The only permanent irregularity therefore will be the crowding of the incisor teeth.

If the adenoids have been severe and of long duration, an additional effect on the arch will be seen in the region of the first molars. The first molar, when erupted, often fails to assume a vertical position, and lies with a general slope backwards. This is well shown in fig. 221, the models of a child who suffered from adenoids. It is not difficult to foresee that, as soon as the second deciduous molar is removed, rapid forward movement of the first molar will result in an encroachment on the space for the premolars and an abnormal occlusion.

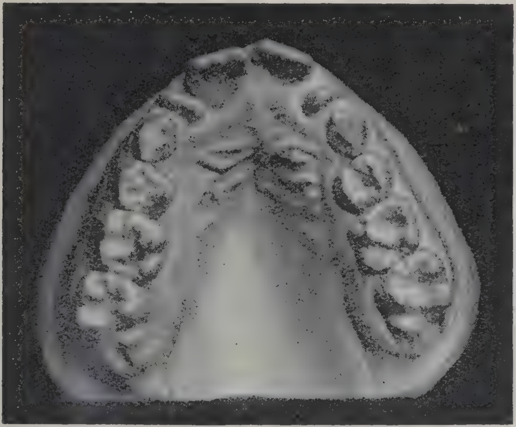

Fig. 220.—Model of the case shown in fig. 219 after the eruption of the incisors. Note the irregular position of the incisors.

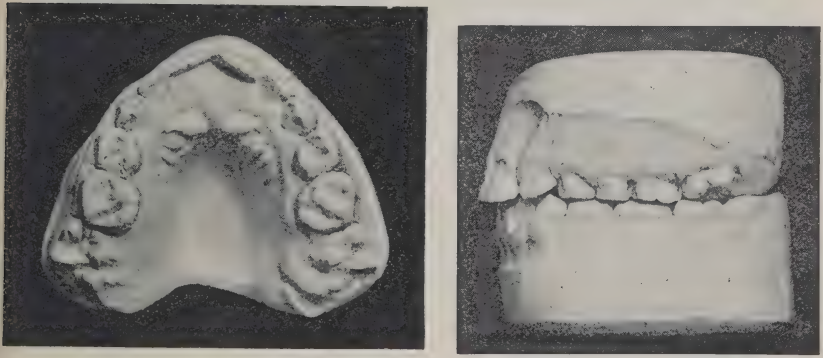

Fig. 221.[1]—Models of a boy aged seven. He had been operated on for adenoids three times.

In some cases the growth in the molar region is so much restricted that the first molar erupts in such a way as to lead to absorption of the posterior roots of the second deciduous molar (fig. 222). Under such conditions it is obvious that abnormal occlusion must result and that the space for the premolars will be considerably curtailed.

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[1] From *Proc. Roy. Soc. Med.*

If the permanent molars do not move forward, the premolars and canines erupt in normal position, and the only deformity of the arch that remains is the slight irregularity of the incisors. If the permanent molars do move forward, the space for the premolars and molars is reduced and a general crowding of these teeth results.

There would appear to be a slight decrease in the width of the arch in children with adenoids, as compared with those free from adenoids, the difference being slightly less than 1 mm. The subjoined figures would appear to substantiate this view.

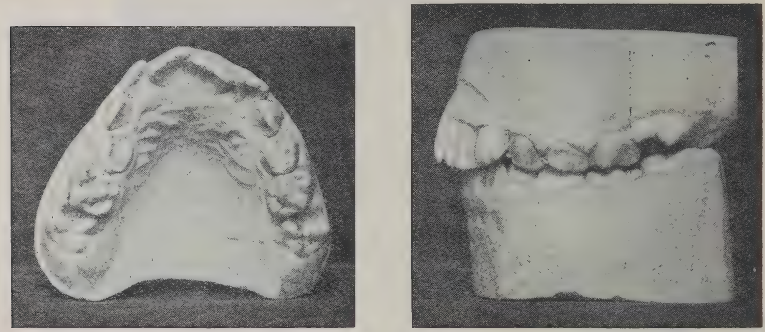

Fig. 222.[1]

	Breast-fed.	
	A	B
Without adenoids (20 cases)	34·85 mm.	26·31 mm.
With ,, (13 ,,)	33·80 ,,	25·19 ,,
Difference	1·05 ,,	1·12 ,,
	Hand-fed.	
Without adenoids (34 cases)	34·10 mm.	25·61 mm.
With ,, (30 ,,)	33·36 ,,	24·90 ,,
Difference	0·74 ,,	0·71 ,,

These measurements are from patients treated in private practice.

With persons who have suffered from adenoids the third molars often erupt with the occluding surfaces facing backwards and outwards.

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[1] From *Proc. Roy. Soc. Med.*

Many of the gross lesions of the jaws which are found in association with adenoids are not necessarily the direct result of the adenoids alone. Usually there are other contributory causes, the influence of which will be considered subsequently.

The Factors Producing the Deformity.—There is a wide divergence of opinion as to the precise manner in which the deformities of the palate associated with adenoids are produced. It has already been pointed out (p. 115) that the efficient performance of nasal respiration is essential for the full growth of the maxilla. This function is hindered or may be entirely in abeyance when there is nasal obstruction, and the result is that the growth of the jaw is considerably hampered.

H. Campbell, dealing with the subject of nasal respiration, says, "When we reflect that a person normally breathes some twenty thousand times through the nose in twenty-four hours, and that the constant flow of air through the nasal passage attracts an abundant supply of blood to the nasal mucous membrane, for the purpose of warming and moistening the air, giving off to it about two quarts of water per diem, it is manifest that the cessation during the developmental period of the respiratory function of the nose must interfere with the proper development of the nasal apparatus, just as early excision of an eyeball tends to defective development of the corresponding orbit."

The interference with growth would appear to occur mainly in the region of the incisors and the molars. Lack of use of the muscles of the anterior nares, in addition to the loss of stimulus to the nasal mucous membrane, inhibits the growth of the premaxillæ. The restriction of growth from this cause would seem to afford an explanation of the fact that crowded incisors are almost always associated with cases in which adenoids develop during the first six years of life. The want of growth in the molar region is due to the lack of expansion of the maxillary sinus arising from disuse, and the want of growth of the maxilla is correlated with a diminished growth of the mandible.

J. G. Turner[1] is of the opinion that the interference with growth of the maxillæ is not due to disuse of the nose, and, in support of his contention, quotes cases in which tracheotomy tubes have been worn by children for years without any ill-results on the nasal or palatal development. He considers that the cause of the failure of maxillary growth in adenoids is obscure.

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[1] *Trans. Inter. Med. Congress*, 1913, Section of Stomatology, p. 57.

The decrease in the width of the arch seen in patients with adenoids may be due to the general want of growth of the maxilla arising from the presence of the adenoids in conjunction with the pressure exerted by the tension of the cheeks in consequence of the open mouth.

The measurements quoted on p. 158 show a slight narrowing of the arch in children affected with adenoids. In many of the cases included in the series the nasal obstruction was not sufficient to cause excessive mouth-breathing and the effect of the tension of the cheeks would not be marked; still further, in each case the full complement of teeth was present. In the breast-fed children affected by adenoids there is a greater proportional narrowing of the arch than in hand-fed children similarly affected. At first sight this difference is rather surprising, but the explanation is as follows: The arch of the breast-fed child is broader and the teeth more spaced than in the hand-fed child; pressure brought to bear on the outer surface of the arch forces the teeth inwards; in the breast-fed child the teeth must move a greater distance before mutual antagonism of the teeth occurs than in the hand-fed child, and hence can be explained the greater proportional reduction in the width of the arch in the breast-fed child. These facts support the view that the tension of the cheeks is an important factor in reducing the width of the arch.

It is evident that when once the teeth are laterally in contact the resistance to the lateral pressure is increased, and that any further narrowing of the arch will depend upon whether the pressure of the cheeks is sufficient to overcome the resistance of the arch. If the mouth-breathing is extreme the effect of the lateral pressure of the cheeks is accentuated and may become sufficient to drive forward the anterior curve of the arch and cause protrusion of the teeth.

If the continuity of the arch is broken by the loss of teeth the narrowing will be accentuated. That the constant tension of the cheeks, and especially the tension of the muscles, does eventually affect the arch is shown by an interesting case recorded by Lambert Lack,[1] in which a child had suffered from unilateral facial paralysis from infancy, in addition to mouth-breathing from adenoids. On the unparalysed side the arch was crushed in, but not on the paralysed side.

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[1] *Trans. 17th Int. Med. Congress*, Section of Stomatology, p. 67.

A word must be said with regard to the high arch of the palate seen in children suffering from marked adenoids. It has been maintained that this is due solely to the lateral pressure of the cheeks, but that view is open to criticism, as in many cases the narrowing is very slight and does not account for the increased height of the palate. It seems probable that the height of the palate may be due to interference with the growth of the sphenoid and the septum of the nose.

" The hard palate in the infant is normally high arched, and at birth it lies above the level of the Eustachian tube, but later on becomes considerably lower. This alteration is due to the downward growth of the hard palate, so that one factor in the production of a highly arched palate is a lack of development of the walls of the nose, more especially of the sphenoid and the septum." Any factor such as adenoids will interfere with the growth of the nasal septum, and so retard the proper development of the hard palate and consequently its descent.

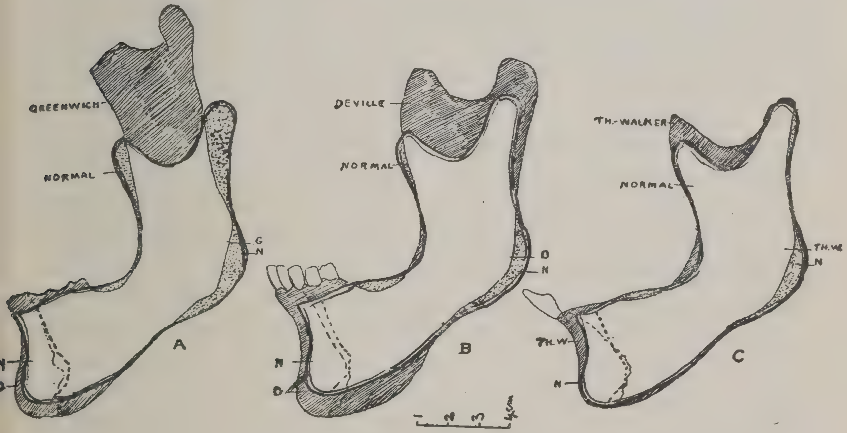

FIG. 223.
From a paper by A. Keith (*Dental Record*).

The views advanced above attribute the dental deformities to the presence of the " adenoids." There are some who do not place the adenoids and the palate deformities in the relation of cause and effect, but consider the enlargement of the adenoid tissues of the naso-pharynx and the disordered growth of the face and jaws as manifestations of a single pathological state the result of nutritional disturbance. Against this view is the fact that on the removal of the adenoids growth appears to proceed in a normal way.

To sum up, it would seem probable that the *deformities asso-*

ciated with adenoids are to be attributed mainly to defective growth of the maxillæ, and that the narrowing of the arch is in a large measure due to the tension of the cheeks, the severity of the deformities depending upon (1) the degree of adenoids and consequent mouth-breathing, (2) the duration of the adenoids, (3) the loss of teeth from the dental arch.

(ii) RICKETS.—Rickets is a constitutional disease in which the bones are particularly liable to suffer. "In the normal increase of a bone in thickness the more central portions of the cancellous structure are gradually removed by absorption, so that the medullary canal slowly but constantly increases in size. Just as fast as this hollowing out progresses within, so fast is new bone laid down by the surrounding periosteum, the proper portions of the compact bone and of the medullary canal being thus maintained." In rickets the hollowing out process goes on and the periosteum continues to lay down the matrix of new bone which, however, is only imperfectly calcified. The new bone retains its form but is softer than normal bone, and mechanical forces acting upon it may change its shape. Under normal conditions a bone is moulded "by the physical forces to which it is subjected, and the muscles acting upon it, and in order to change the form of a bone we must either apply artificial force or a stimulus directly or indirectly through changed muscular action." The jaws in health preserve their form under stress of mastication, and similarly when the bone is soft and there is corresponding muscular weakness no change of form occurs. H. K. Hatfield,[1] who examined fifteen children with a clear diagnosis of rickets, found that in the jaw development there was nothing which could be regarded as characteristic of rickets.

If, however, the functional equilibrium is disturbed by the introduction of an artificial force such as a "dummy" or if a change of muscular pressure takes place, as in mouth-breathing, deformity ensues. These altered conditions produce deformities even in healthy bones, but in rickets, owing to softening of bone, the deformities are increased.

(iii) ACROMEGALY.—In this condition growth recommences in certain parts of the body, the mandible being one of the parts affected. The ramus elongates, there is growth along the alveolar border, at the chin, and also at the lower border of the bone. These changes are diagrammatically shown in fig. 223, the mandible of a normal person being superimposed on that of three acromegalic mandibles.

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[1] *Dental Items of Interest*, September, 1919.

A. Keith,[1] who has given considerable attention to the subject, considers that the increased growth is due to over-action of the pituitary secretion. "It somehow sensitizes the osteoblasts of the masticatory apparatus—not only wakens up growth in them, but renders them highly susceptible to the mechanical influences to which they are subject when in action."

(iv) OXYCEPHALY.—In the condition known as oxycephaly the maxillæ are poorly developed, the length of the maxilla being reduced in proportion to the anterior-posterior diameter of the skull. The maxillary sinus is usually rudimentary. The mandible is not affected.

Morley Fletcher[2] thus describes the jaws in a case of well-marked oxycephaly: "The superior maxilla was shortened from before backwards. The hard palate formed a narrow, very pointed arch. The second and third molars were absent in the upper jaw and could be made out in the radiogram lying above on what appeared to be rudimentary antra. Lower jaw underhung teeth normal in number."

In oxycephaly there is synostosis of the coronal and sagittal sutures and this leads to a lack of growth of the maxilla. There is some evidence that the changes are related to an alteration or abnormal development in the pituitary body.

(v) PROGERIA.—This interesting condition was first described by Hastings Gilford. It is a case of delayed or arrested growth—infantilism—to which is added senilism, a term used to designate prematurely senile changes.

The skeletal changes in a case of progeria have been fully described by A. Keith.[3] The condition of the jaws and teeth is most instructive because it seems to shed light on the problem of the crowded mouth. The palate is very little larger than that of a child at birth, the length being less reduced than the width. On the other hand, the teeth are as advanced in formation as one would expect to find in an individual of eighteen years of age, but are placed in an irregular manner. The second incisors and third molars are absent and the canine unerupted. In the mandible the second incisors are absent, the premolars are embedded in the bone, the first molars have been destroyed by caries, and the second molars are erupting from the inner aspect of the coronoid process. The third molars are absent (figs. 224 and 225).

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[1] "Certain Factors in Tooth Eruption," *Dental Record,* vol. xxxiii, p. 769.

[2] "On Oxycephaly," *Quarterly Journal of Medicine,* April, 1911, vol. iv, No. 15.

[3] "Progeria and Ateleiosis," *Lancet,* February 7, 1913.

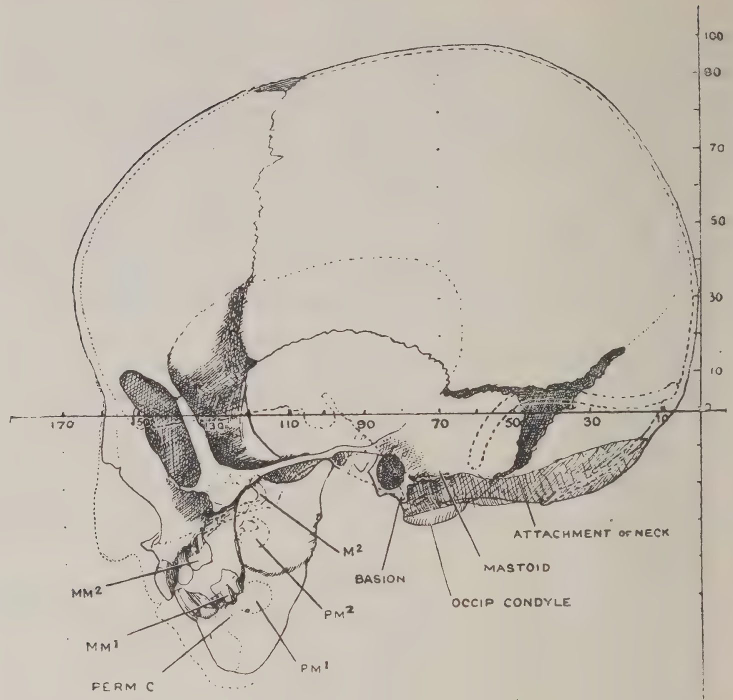

Fig. 224.
From a paper by A. Keith (*Dental Record*).

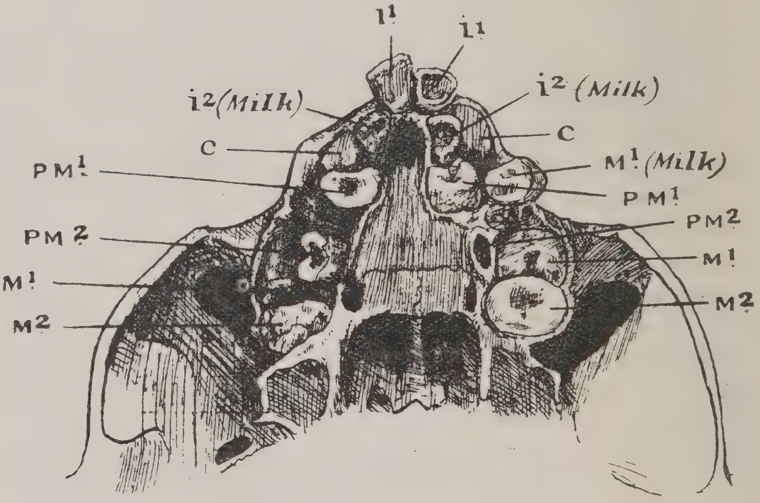

Fig. 225.
From a paper by A. Keith (*Dental Record*).

(vi) ACHONDROPLASIA.—In this disease there is a slowing down or arrest of bone growth at epiphyseal lines and, owing to synostosis of the bones of the base of the skull, the maxilla may be deformed. The malformation consists in a retraction of the face and a tilting upwards of the anterior part of the palate.

The manner in which the teeth and jaws are affected in cases of acromegaly, &c., where the disease is well marked is indicated above. It is probable that these diseases are frequently present in a lesser degree, and that with further knowledge they will be found to be a more common cause of irregularities of the teeth than has hitherto been suspected.

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CHAPTER VI

Abnormalities in Position of the Teeth.—Treatment

Treatment in General—The Movement of Teeth by Mechanical Appliances—The Movement of Teeth by Surgical Methods

(A) TREATMENT IN GENERAL

(1) Prophylactic.—Our knowledge of the causes of irregularities of the teeth is as yet far from complete, but year by year investigation discloses fresh facts which assist us in removing or ameliorating those causes, and it is important, therefore, that the student should keep closely in touch with the results of recent research.

It is of primary importance that breast-feeding should be insisted on wherever it is practicable, but if hand-feeding is necessary the food should be administered for preference by means of the spoon or feeding-cup. The use of the comforter should be strongly deprecated. Every care should be taken to prevent caries of the deciduous teeth. A diet requiring plenty of mastication is essential, and proper nasal breathing should be assiduously encouraged. Should nasal obstruction be caused through the presence of adenoids, or from any other condition, treatment should be accorded as speedily as possible, in order that proper nasal respiration may be restored. If the teeth of a breast-fed child are maintained in a healthy and efficient state and nasal breathing is promoted there is little danger of irregularities arising during the second dentition.

Careful supervision of the mouth during the period of dentition will go far to prevent or, at any rate, to ameliorate irregularities.

Early treatment of caries in the deciduous molars will often prevent their premature loss, while the timely removal of a deciduous tooth will often prevent a permanent tooth from assuming an abnormal position. Special attention should be bestowed upon the first permanent molars. Any cavities which appear should immediately be filled. If caries does appear on the anterior surface of the permanent molar, the advisability of removing the second deciduous molar and making the surface of the permanent molar self-cleansing must be considered. The successful preservation of the first permanent molar far outweighs in importance the slight moving forward of the tooth which might result from the removal of the second deciduous molar. To secure good results, children's teeth should be examined at least three times a year, and the necessity for constant supervision should be impressed on the parents.

(2) Remedial.—Whenever there is doubt as to the best method of treatment it is advisable to take **models of the mouth** to be studied in connection with a chart on which the condition of the teeth has been carefully noted. In this way points often become apparent which would be missed by a mere examination of the mouth. Where a case comes under observation at an early stage, it is advisable to take models periodically in order that the development of the mouth can be watched and perhaps some light gained as to the best method to pursue in the treatment.

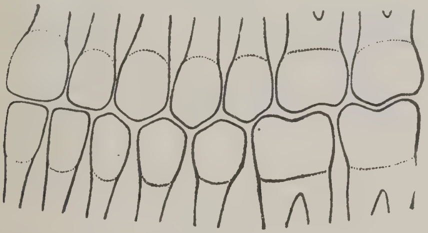

FIG. 226.

The teeth must be carefully examined with special reference to the following points:—

(*a*) The general character of the teeth.

(*β*) The presence and extent of caries, especially on the approximal surfaces.

(*γ*) The directions of the roots of the teeth. (The value of this point is referred to on p. 244.)

(*δ*) The occlusion of the teeth.

The last point is of special importance if extraction is indicated. Many of the indifferent results which follow treatment by extraction are due to the removal of teeth without regard to occlusion.

The teeth have a natural tendency to move from their normal positions in the mouth termed "**travelling of the teeth,**" and in connection with this movement the "bite" or occlusion of the teeth plays an important part. If a normal articulation (fig. 226) be examined, it will be observed that the opposing teeth present inclined planes to one another, and this is particularly noticeable in the premolar region. With each act of mastication pressure is brought to bear upon these surfaces and as long as the resistance remains equal in all directions the tooth retains its position. Remove this resistance, wholly or in part, and the force exerted by the muscles with each act of mastication will tend to force the teeth in the direction of least resistance. Take, as an example, the case diagrammatically illustrated in fig. 227. The first molars have been removed. Each time the posterior plane of the mandibular second premolar strikes the anterior plane of the maxillary second premolar the tendency will be to drive the latter tooth in the direction of least resistance, namely, backwards. When once this tooth has travelled backwards, the resistance to the movement of the mandibular second premolar in the posterior direction is removed, so that the force of the posterior plane of the maxillary first premolar striking the anterior plane of the mandibular second premolar will tend to drive the latter also in a backward direction. In like manner, the posterior plane of the mandibular first premolar will tend to drive back the maxillary first premolar. In addition to the power derived from the muscles of mastication, the force exerted by the lips, tongue and the process of eruption are important factors in producing the natural movement of teeth. The lips

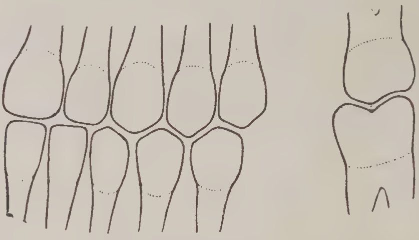

FIG. 227.

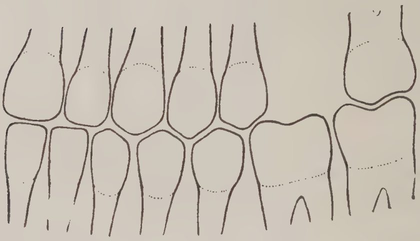

FIG. 228.

exert force in a backward direction, the tongue in a forward direction. When employing extraction for the correction of an irregularity, an endeavour should be made to "unlock" the bite. This will be more easily understood by a reference to fig. 228. For the sake of argument we will suppose that the canine has erupted externally to the arch. To provide space the maxillary first molar only is removed. The bite will remain locked—in other words, the second premolar will require mechanical means to train it in a backward direction, and even then will occlude with the molar—an unsatisfactory condition. Mechanical means will also be required to retract the first premolar. If the mandibular first molar is removed as well as the maxillary, mechanical methods can be avoided to a very great extent, and there will be less interference with the efficiency of the bite.

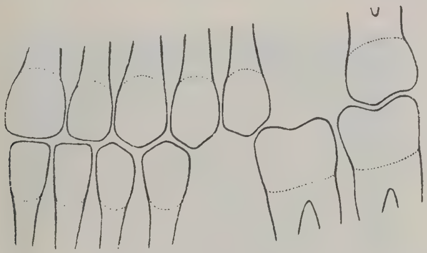

FIG. 229.

When removing teeth in both maxilla and mandible, opposing teeth should if possible be selected. A glance at the diagram (fig. 229) will show the disadvantage of not following this course. In the maxilla the first molar has been removed, and in the mandible the second premolar. There is considerable destruction of the masticating area, and moreover mechanical methods must be used to retract the teeth. Removal of the maxillary and mandibular second premolars, or the maxillary and mandibular first molars, would have interfered far less with the masticating area, and would have unlocked the bite and allowed the teeth to travel backwards unaided by mechanical means.

In employing extraction the desirability of maintaining the **Teeth in their proper relation to the Median Line of the Face** should, for æsthetic reasons, be borne in mind. Any deviation to one side or the other in the direction of the incisors causes an appreciable disfigurement, and, in the case of girls, this is important from an æsthetic point of view. The centre of the mouth is likely to shift when the bite is unlocked on one side and not on the other.

Take, as an example, a case where it has been necessary to remove the maxillary first premolar on the left side. The posterior resistance to the canine and second incisors being removed the pressure of the lip tends to drive all the anterior teeth to that side and so causes the centre to shift. An example is shown in fig. 230. The patient's appearance has suffered considerably. Removal of the maxillary right first premolar as well as the maxillary left first premolar would have prevented the disfigurement because, the posterior resistance on both sides being removed, the lips would have forced back the anterior teeth equally on both sides. Removal of one maxillary second premolar will not cause the centre to shift because the bite will be locked by the maxillary first premolar occluding with the mandibular premolars, but removal of the fellow tooth in the mandible will withdraw the posterior resistance and permit the first premolars—maxillary and mandibular—to shift back and so produce an alteration in the centre of the mouth. Other examples could be quoted. Removal of the maxillary and mandibular right first molars and the maxillary left first molar would cause the centre to shift towards the right side because the bite is locked on one side and not on the other.

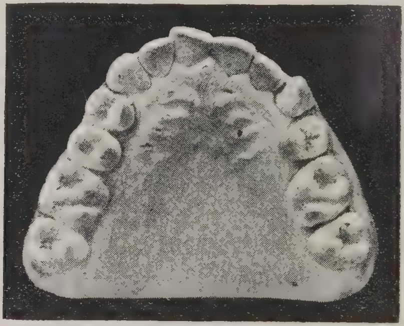

FIG. 230.

Radiograms of the teeth will be found most useful in cases where doubt exists as to the directions of the roots of teeth, or as to the presence or absence of unerupted teeth.

In any case where there is a question of treatment by mechanical methods the **general health and temperament** of the patient must be considered. With weak, nervous children mechanical treatment should, for obvious reasons, be avoided if possible. Again, in all cases requiring mechanical treatment the thorough co-operation of parents and patients is most essential to success. Regulating apparatus, unless constantly worn and properly attended to, does more harm than good. If the practitioner has reason to believe that his instructions will not be faithfully carried out, prolonged mechanical treatment should be avoided.

Other points to be considered are the **age** and the **sex** of the patient. With regard to the former it should be remembered that the difficulty of moving and retaining the teeth in a new position increases with the age of the patient. As a rule, it is not advisable to attempt correction of irregular teeth by mechanical means in adults. The older the patient the more difficult the teeth are to move and retain in a new position. Again, the older the patient the greater the danger of starting pathological changes in the periodontal membrane.

In deciding on the method of treatment, attention must be given to the **facial expression and type of face.** For example, a narrow arch may be accompanied by a narrow face with a small mouth and correspondingly small features, all of which are in harmony. Expansion or spreading of the arch under such conditions might mar the character of the face.

The removal of the canine usually produces an ugly flatness of the upper lip and allows the angles of the nose to sink.

In cases where, with protrusion of the maxillary teeth, the lower lip is unduly flat, but the mandibular teeth are crowded, with perhaps the canines slightly prominent, an attempt to regulate the canines by bringing them into line will tend to increase the flatness of the lower lip and to accentuate the protrusion of the maxillary teeth.

(B) MOVEMENT OF TEETH BY MECHANICAL MEANS AND REGULATING APPLIANCES

The movement of teeth by mechanical means is accomplished by the application of certain forces which act from a fixed base known as "*the point of delivery.*" The resistance of the point of delivery, or anchorage, must be greater than that of the tooth or teeth to be moved. This is an essential condition which is frequently overlooked.

The point of delivery is usually obtained from the resistance of teeth either by means of a well-fitting plate or by embracing two or more teeth with a clamp or band, the force to be used being attached to the plate or band. In a few forms of apparatus the occiput is utilized as the point of delivery. Regulating appliances are thus divisible into two main groups: (α) removable, (β) fixed.

(α) **Removable Appliances.**—The successful working of a regulation plate depends mainly upon accurate fitting, and great care should therefore be taken in obtaining models of the mouth. The best material for the plate is vulcanite. The back teeth should usually be capped, as the real point of delivery is obtained from the teeth, and by capping them a much firmer hold can be obtained. Plates must be carefully adjusted to the bite of the opposing teeth. The plate should be tried in the mouth and the bite adjusted by the aid of a proper articulator. It is advisable to allow the lower teeth to bite well "home" into the vulcanite as the plate is then kept more firmly in position, and, when the mouth is closed, the opposing teeth also act as part of the point of delivery.

The Forces employed for Moving Teeth.—(i) **The screw** is perhaps the most powerful. The types suggested by E. H. Angle are neat and efficient.

The screw must be adjusted at regular fixed intervals, only a slight degree of force being applied at each visit. The force exerted by a screw is not continuous, but this is evidently no disadvantage as the results obtained from screw force in regulating teeth are entirely satisfactory.

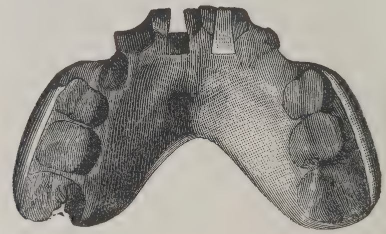

FIG. 231.

(ii) **The Wedge.**—**Hickory wood** compressed laterally is mostly used. The saliva moistens the wood, causing it to expand and so exert force. In using wooden wedges, the grain of the wood should lie parallel to the direction in which it is proposed to move the tooth. The wedge will be found most useful for forcing incisors forward. The method of adjusting the wooden wedge is shown in fig. 231. A double dovetailed slot is cut in the vulcanite plate, one broad end being away from the tooth and the other being towards the palatal aspect of the plate. Into this slot the hickory wedge is placed.

Wedging may be carried out by the aid of vulcanite pegs. Cone-shaped holes are drilled in the plate and, in place of the rubber, a vulcanite peg is inserted and is left sufficiently long to prevent the plate being forced at once into place. The peg is also arranged with a sloping surface so that at first it presses on the tooth near the cutting edge, and as the plate is driven up into place by the lower teeth so the tooth is forced forwards. It is important that the mandibular incisors should occlude with the plate and so increase the force transmitted to the teeth to be moved.

(iii) **The inclined plane** is most usefully employed when it is necessary to force forwards three or four maxillary incisors. For this purpose a plate is made capping the mandibular teeth and an inclined plane is fixed to the plate, so that when the mouth is closed the teeth to be moved impinge on the sloping surface and are thus driven forward. The inclined plane must be used with care as the soft tissues may be injured if the teeth are forced forward too quickly.

(iv) **Elasticity.**—The force obtained from the elastic properties both of rubber and metals, especially the latter, is most useful for mechanical regulation of teeth.

(*a*) *Rubber.*—This material is generally used in the form of small bands. There is always some difficulty in retaining the bands in position on the teeth, the tendency being for the bands to slip towards the necks of the teeth and cause inflammation. This can be overcome by cementing to the teeth metal bands with hooks attached. The rubber bands require frequent renewal and are somewhat uncertain in their action.

(*b*) *Pianoforte Wire.*—This is a most useful material, light, strong and inexpensive, and in skilful hands it is capable of being utilized to produce any movement, i.e., pulsion, traction, or torsion of a tooth. Moreover it is constant in its action and can be easily controlled. The wire used should be thin (gauges No. 14 to 17). The disadvantage of the wire is the tendency to oxidize in the vulcanizer, but this can be overcome by tinning the wire. The following method is suggested by T. A. Coysh.[1]

"After cleaning the wire thoroughly it is dipped into chloride of zinc solution and then for an instant into melted tin which must not be too hot and the surface of which must be quite clear. Upon removal from this the surplus molten tin is quickly shaken off and the spring cooled in cold water."

Pianoforte wire is used to the best advantage when curved or coiled; in this way greater springiness is obtained. The twist given may be similar to that shown in fig. 232, or to that seen in fig. 233. For the manipulation of pianoforte wire the pliers designed by G. Northcroft and shown in fig. 234 will be found most useful. In twisting the wire, anything approaching an angular bend must be avoided. Care must be taken to arrange that the force of the spring acts in the direction in which the tooth is to be moved. A bend should be made in the wire at the free end where it impinges on the tooth as the wire can then be more easily adjusted in the direction required. It is also important that the coil or turn which gives the spring should be in a plane parallel to the direction of the required force. In figs. 235 to 242 some methods of employing pianoforte wire are shown.

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[1] *Dental Record,* vol. xi, p. 109.

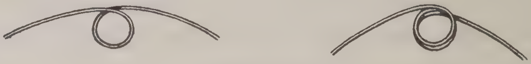

FIG. 232.

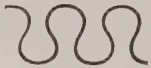

FIG. 233

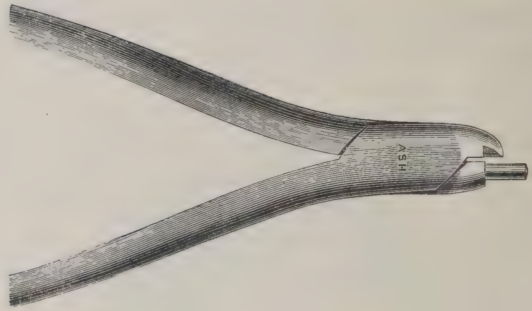

FIG. 234.

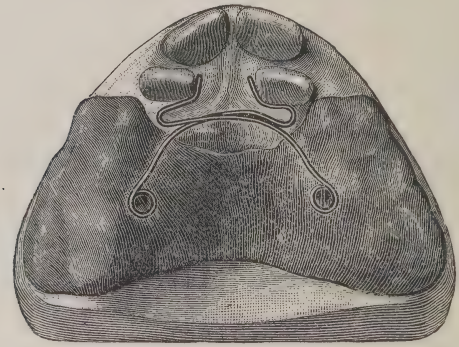

FIG. 235.—Plate for pushing outwards and rotating second incisors.

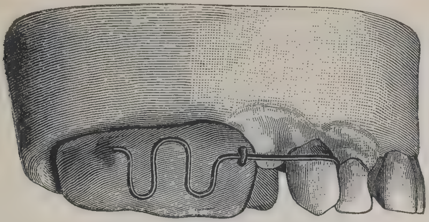

FIG. 236.—Plate for retracting a canine.

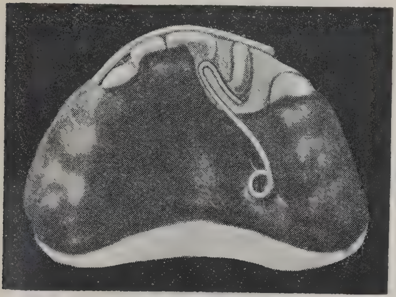

FIG. 237.—Plate for rotating a maxillary first incisor.

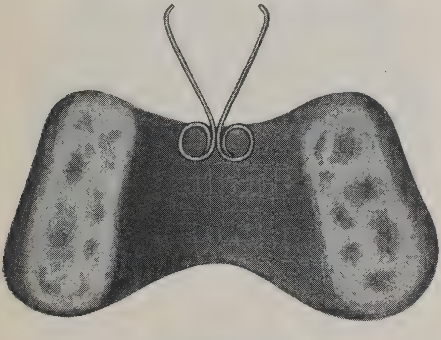

FIG. 238.—Plate for drawing together first incisors.

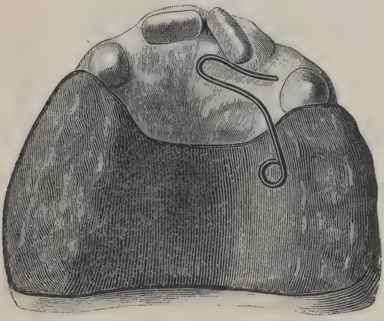

FIG. 239.—Plate for pushing outwards the distal side of a maxillary first incisor, and at the same time slightly rotating it.

(c) *Gold Wire* can be used in place of pianoforte wire for regulating. It may be made fairly springy by gentle hammering, but the peculiar elasticity of the steel wire cannot be obtained. Gold wire is neater in appearance, does not stain the teeth, and does not oxidize.

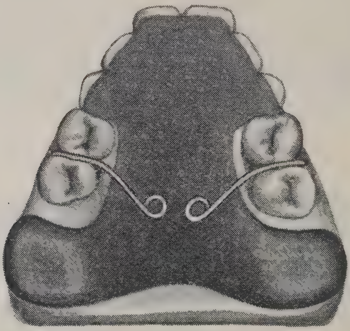

Fig. 240.—Plate for retracting premolars.

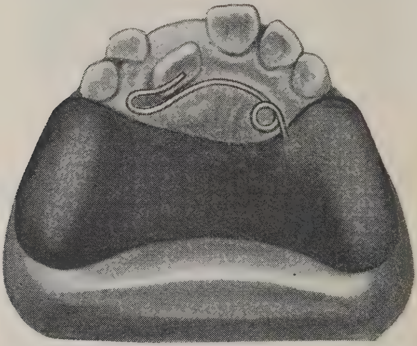

Fig. 241.—Plate for pushing forwards a maxillary incisor.

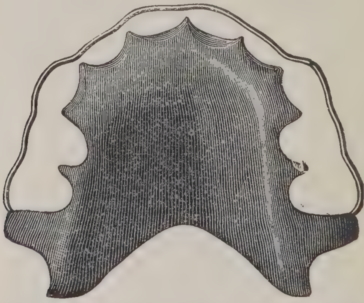

Fig. 242.—Plate for retaining the teeth in position after regulation.

In the type of appliance advocated by W. H. Jackson the anchorage is obtained by spring clasp attachments supporting a base wire to which any form of spring can be added. The clasp is made by bending a thin piece of plate-metal to fit the labial or palatal aspect of the tooth (fig. 243). A piece of spring wire about No. 21 (American gauge) is fitted around the neck of the tooth on the opposite side from that covered by the thin metal (fig. 244). The ends of the wire are then bent in the manner shown in fig. 245 and soldered to the plate of metal. The grasping power of this attachment depends upon the elastic properties and strength of the metals used. The spring clasps are united by a strong base wire, and to this wire are attached the various spring wires required.

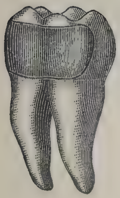

FIG. 243.[1]

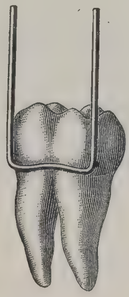

FIG. 244.

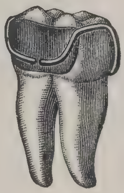

FIG. 245.

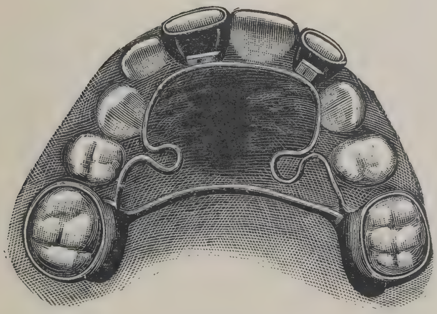

FIG. 246.

Fig. 246 illustrates a method of moving incisor teeth outwards. Anchorage is obtained on the first molars. Collars with lugs are attached to the incisors to be moved. The moving force is obtained by soldering a spring to the base bar. The loop of the spring is opened every three or four days. W. H. Jackson claims that his appliances are simple, occupy but little room and can be easily removed and adjusted.

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[1] For the use of figs. 243 to 246 I am indebted to Messrs. Lippincott, the publishers of "Orthodontia," by W. H. Jackson.

(β) **Fixed Appliances.**—With fixed forms of appliances the "point of delivery" is obtained by banding two or more teeth and fixing to the bands the force to be employed. For the following description of fixed appliances I am indebted to Harold Chapman, who has made a special study of this branch of dental surgery.

The form of fixed appliance which finds favour with the majority of practitioners consists of bands attached to certain teeth, the bands being connected by a wire which is placed either on the lingual or labial aspects of the teeth. This curved piece of wire is generally known as the "arch," and may be employed as a base for the attachment of auxiliary springs which deliver the force. In young children the anchor bands should be fixed to the second deciduous molars, in older children to the first permanent molars. The canines may be utilized when it is desired only to increase the distance between these teeth to provide room for the incisors.

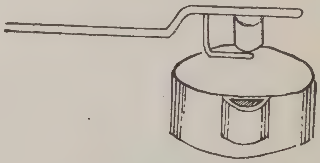

Fig. 247.—Locking device for attaching the lingual arch to the anchor bands.

(By permission of Messrs. H. Kimpton, from "Applied Orthodontia," by J. D. McCoy.)

The anchor bands, which should be made of iridio-platinum or platinized gold, may be fitted directly to the teeth or they may be made on models of the teeth. Tubes are soldered to the bands to form an attachment for the arch. The arches should be made of platinized gold with a high percentage of platinum to make a springy alloy.

When a labial arch is employed, the ends—which should be "threaded" and should carry nuts when labial movement of incisors is required—pass through horizontal tubes soldered to the anchor bands. The lingual arch may be attached to the bands by the device shown in fig. 247. A half round post is fixed to the arch which fits closely into a half round tube soldered in a vertical position to the band. A lock wire is attached to the arch to prevent it being dislodged. This form of attachment is also used for buccal arches. A model showing a lingual arch in position is shown in fig. 248.

Auxiliary springs, if used, should be soldered to the gingival side of the arch and at right angles to the main arch; the spring is then bent back across the arch wire and again bent to the curvature required (fig. 249). Convenient situations for the attachment of auxiliary springs are shown in fig. 250.

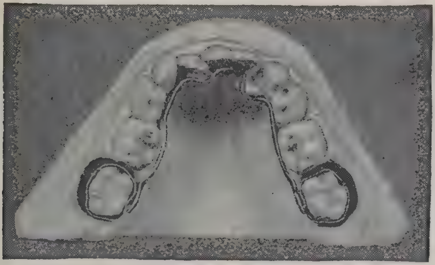

FIG. 248.—Showing lingual arch wire correctly adapted to the mandibular teeth, i.e., it is passive in its relation to all the teeth.

(By permission of Messrs. H. Kimpton, from "Applied Orthodontia," by J. D. McCoy.)

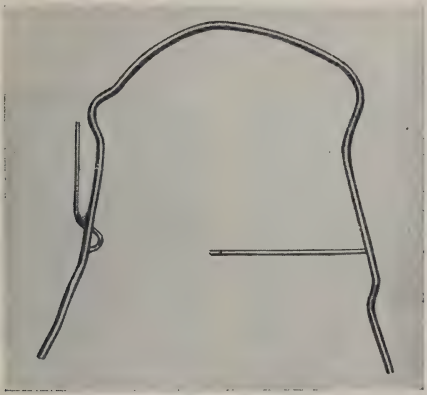

FIG. 249.—Showing method of attaching auxiliary springs to the lingual arch. From a paper by J. V. Mershon.

(By permission of *Dental Cosmos.*)

The buccal movement of teeth, when the buccal arch is used, is brought about as follows: the wire is bent to a shape near to that of the desired arch and is then attached to the anchor bands, the teeth to be moved being ligatured to the arch. It is advisable to fix bands carrying spurs when teeth are to be rotated, or tubes or brackets when bodily movement is required, whereby these movements can be efficiently controlled, fig. 251 (see also p. 30, Angle's arch.)

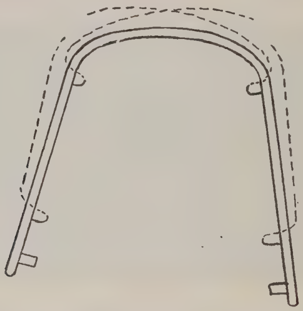

Fig. 250.—Diagram showing convenient locations for the attachment of auxiliary springs.

(By permission of Messrs. H. Kimpton, from "Applied Orthodontia," by J. D. McCoy.)

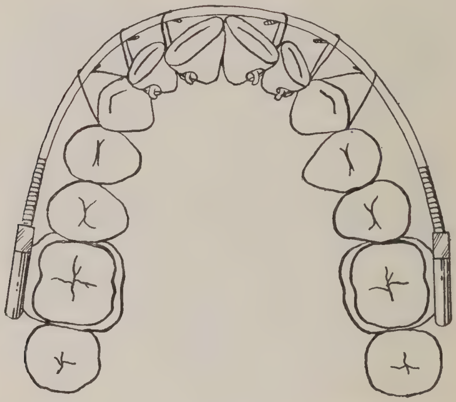

Fig. 251.

(By permission of Messrs. H. Kimpton, from "Applied Orthodontia," by J. D. McCoy.)

When a lingual arch is employed the force may be produced by lengthening the arch. The base wire is bent to lie at the necks of the teeth, U-shaped loops (the open ends of which are towards the occlusal surfaces of the teeth) are made in the wire according to the force to be developed. If expansion of the arch is required a loop is made on each side a little forward of the molar attachment, and another in the centre just posterior to the mandibular first incisors; the loops should be opened every three or four weeks. By opening the loops a change is produced in the alignment of the arch; to overcome this a counter-bend should be made, usually at the point where the U-shaped loop begins. The arch may also be lengthened by stretching the wire with suitable pliers.

The movement of teeth is also carried out by the use of auxiliary springs. In fig. 252 the position of the incisor teeth has been corrected by the aid of two springs attached to the main arch, one on each side opposite the premolar teeth.

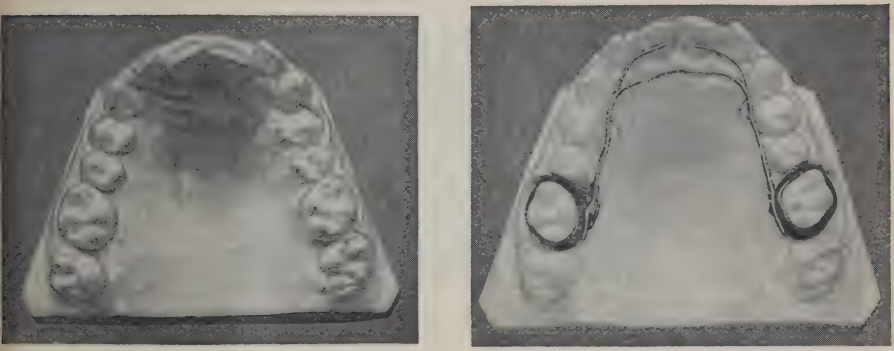

Fig. 252.—To show the use of auxiliary springs attached to a labial arch. (From a paper by J. V. Mershon, *Dental Cosmos*.)

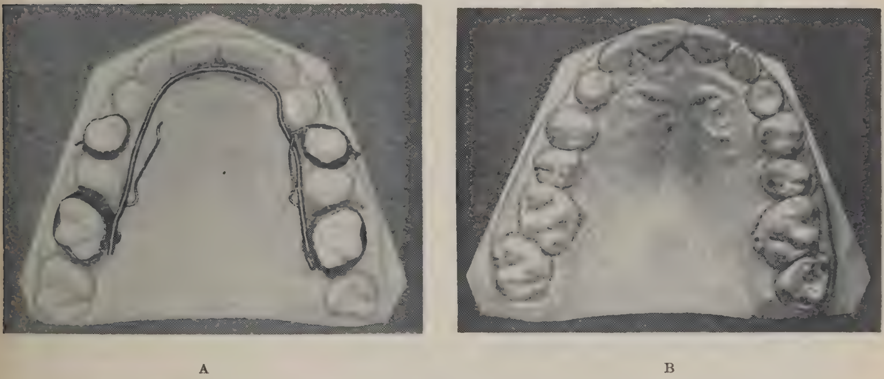

Fig. 253.—Case showing A, springs in position; B, the teeth rotated. (From a paper by J. V. Mershon, *Dental Cosmos*.)

The rotation of teeth may be accomplished by adjusting a band to the tooth with a spur attached to the labial side of the band (fig. 253). A spring wire is soldered to the arch a little distance from the tooth to be rotated, the spring is then bent almost parallel to the main arch. Over the free end of the spring, which should now rest some distance from the arch, a fine ligature wire is placed and passed through the gingival space to engage the spur on the band. The ligature wire should then be tightened until the auxiliary spring is in contact with the lingual arch.

The inclinational movement (tipping) of teeth may be achieved by applying pressure as near as possible to the cutting edge; the movement may be aided by actual pressure or simple resistance from another arch at the cervical edge of the opposite surface of the tooth.

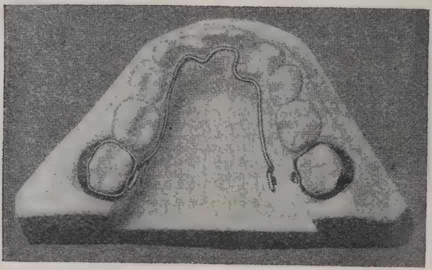

Fig. 254.—Incorrect adaptation of lingual arch wire. If locked in place in this state, the anchor teeth will be subjected to disadvantageous pressure. (By permission of Messrs. H. Kimpton, from "Applied Orthodontia," by J. D. McCoy.)

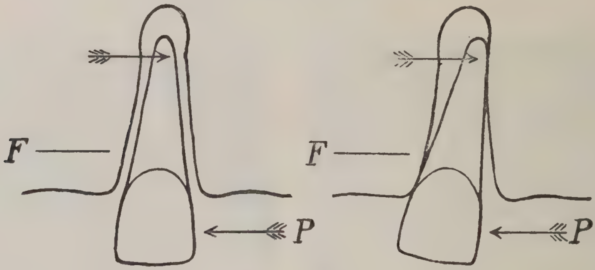

Fig. 255.

Fig. 254 is shown to emphasize the importance of correctly adjusting the arch; in this case the first permanent molars need buccal movement or expansion, but if the arch were shaped to lie in the mouth at rest, as illustrated, and then fixed to its attachments, the molars would be moved lingually instead of buccally.

The foregoing examples of mechanical appliances are merely intended to indicate the range of application of the various forces used for the mechanical movement of the teeth. The works of Angle, Dewey, Lischer, Guildford, Jackson, Case and McCoy contain full accounts of the various forms of apparatus in use.

Choosing between the Use of Removable and Fixed Apparatus.—In deciding upon the particular apparatus to be used the peculiarities of the case to be treated must of course be considered. Removable apparatus has a distinct advantage in that both the apparatus and the mouth can easily be kept clean. Moreover, with fixed apparatus the adjustment of the bands to the teeth must necessarily entail some damage to the gingival margin even in the most skilful hands, a point of importance in relation to periodontal disease.

(γ) Changes in the Tissues Produced by Mechanical Movement.—The position which a tooth assumes when acted upon by mechanical appliances depends largely upon the manner in which force is applied.

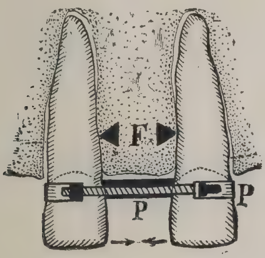

FIG. 256. (Farrar.)

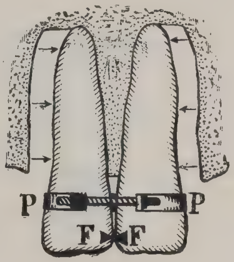

FIG. 257. (Farrar.)

With the majority of appliances a movement similar to that shown in fig. 255 takes place. The force P, which is applied to the crown, is transmitted to the opposing portion of the alveolar process F, and in proportion to the resistance here met with, the apex is moved in the opposite direction. The movement of the apex is probably only slight, and for practical purposes **the tooth may be said to move in the arc of a circle,** the centre of which is represented by the apex of the tooth.

Under certain conditions it is possible to apply force so as to move both crown and apex in the same direction. The diagrams (figs. 256 and 257) illustrate one method by which this movement may be produced. If a clamp band is attached to two separated first incisors, the immediate result of applying force will be to approximate the mesial angles and cause the apical portions of the roots to diverge. When the mesial angles come into contact, the fulcrum will be shifted from the alveolus to the point of contact in the crowns and the continued application of force will cause the teeth to approximate throughout their whole length until they become parallel (see fig. 257). It will be noticed that, whilst the alveolar process forms the point of resistance, the apices tend to move in directions reverse from the crowns, but directly the fulcrum is transferred to the crowns the apices commence to approximate. This creation of a static fulcrum on some portion of the crown near the occluding surface and the application of force as high up on the tooth as possible are the fundamental principles underlying all appliances which claim to move the roots of the teeth bodily.

The method introduced by C. S. Case of Chicago is ingenious. The tooth is banded and to the band an upright bar, C, is soldered (see fig. 258). To the lower end of C a traction bar, F, is fixed, this bar being united to the point of delivery. Force is applied by connecting the upper part of the bar C with the point of delivery by means of a bar, P. By adjusting the screws connected with the bars P and F, the root or the entire tooth can be moved backwards or forwards as required.

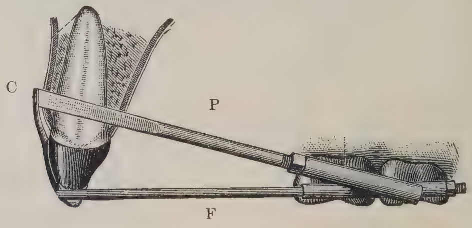

FIG. 258.[1]

When pressure is applied to a tooth, the alveolar wall, against which the pressure is indirectly applied, undergoes absorption; when the tooth has been moved into the position required and is retained there firmly by suitable means, a fresh deposition of bone takes place and a new socket is formed. The rapidity with which this fresh bone is deposited depends upon (1) the recuperative powers of the patient; (2) the retention or non-retention of the tooth firmly in its new position by suitable means during the period the tissue is forming; (3) the amount of local disturbance caused by the operation.

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[1] From "Text-book of Operative Dentistry" (Kirk).

(δ) Complications and Sequelæ of Mechanical Movement of the Teeth

(i) **Periodontitis.**—Injury to the periodontal membrane may result from the application of too great a force to the tooth or from direct impingement of the force on the membrane through faulty adjustment. The inflammation of the periodontal membrane may spread to the pulp and so cause death. Chronic periodontitis frequently attacks teeth which have been moved. The changes which occur during regulation may tend to lower the vitality of the tissues and so render them liable to attack.

(ii) **Caries.**—This is to a great extent an avoidable sequela. The cleaner the apparatus and mouth are kept the less will be the liability to caries. Movable types of apparatus have in this respect a decided advantage over fixed types. The mouth and all mechanical appliances must be carefully cleaned after every meal. Before inserting the plate an alkaline mouth-wash[1] should be used, and it is also advisable to run a little of the fluid over the surface of the plate where it comes in contact with the teeth.

(iii) **Permanent Enlargement of the Alveoli.**—This condition is due to inadequate re-formation of bone after the tooth has assumed its new position. There may be a lack of recuperative power on the part of the individual from general causes. Growing tissues are more likely to recuperate than tissues which are fully developed and hence it is that permanent enlargement of the alveoli is frequently met with in cases of regulation in adults. The enlargement of the alveoli may be the result of inflammatory changes in the tissues due to want of care in regulating. Teeth which have been moved should be retained firmly in their new position, otherwise permanent enlargement of the alveoli may result from undue movement in the socket.

(iv) **Injury of the Gums.**—In cases where the regulation has been too rapidly carried out, inflammation of the gums frequently occurs. Inflammation may also arise from want of care in cleansing

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[1] The following is suggested :—

℞	Mag. carb. levis	ʒiv.
	Aq. rosæ	℥vi.
	Aquam ad	℥xii.

M. Shake before using.

After the mouth has been thoroughly cleansed, a tablespoonful is to be taken and moved about in the mouth between the teeth. The magnesia, which is only in suspension, clings about the necks of the teeth and neutralizes any acid. Ordinary solutions of alkalies have only a transient effect upon the oral secretions.

the plate. The application of a little tincture of iodine, powdered tannic acid, or some other suitable astringent generally removes the trouble. If, however, the inflammation increases, the application of force must be postponed until the gums return to normal condition.

If, owing to defective adjustment, the plate presses on the gums and not on the teeth, sloughing of the soft tissues may occur. Under these conditions the regulating appliance must be immediately abandoned and must not be used again until the tissues have assumed a healthy condition.

(C) THE MOVEMENT OF TEETH BY SURGICAL METHODS

The immediate regulation of teeth may be carried out by surgical methods. W. H. Dolamore has had extensive experience of this method and suggests the following *modus operandi*:—

The mouth should be freed from sepsis. Using a modified Hey's saw, with a very thin blade, the gum and alveolar process are sawn through midway between the teeth on both sides and nearly to the apex of the misplaced tooth. The tooth is then moved towards its correct position, the movement being completed by forcing on a metal cap splint made to a corrected model. The splint, lined with cement, fixes the moved tooth or teeth in the new position. It is left on for at least six weeks. The cut is carried through the alveolar process merely for convenience. When moving a tooth outwards the inner alveolar plate does not move. As in immediate torsion a block of gutta percha is used between the blades of the forceps to prevent the tooth from jumping out. A full account of this method will be found in the paper by W. H. Dolamore (*Trans. Odonto. Soc.*, vol. xxxii, p. 42).

So far the methods of treatment have only been described in a general way, and it is now necessary to enter into fuller details as to the methods to be adopted in individual cases. For this purpose irregularities may be divided into clinical groups and the following grouping will be adopted:—

(A) Abnormalities in position of individual teeth.

(B) Abnormalities in position of several teeth—General crowding.

(C) Undue protrusion of the anterior maxillary teeth—Superior protrusion.

(D) Protrusion of the mandibular teeth—Inferior protrusion.

(E) Lack of occlusion—Open bite.

(F) Abnormalities of the teeth associated with congenital defects of the jaw.

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DOLAMORE, W. H. "The Treatment of Misplaced Teeth by Alveolotomy," *Trans. Odonto. Soc.*, vol. xxxii, p. 42.

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SPOKES, S. "The Forcible Advancement of In-growing Teeth," *Trans. Odonto. Soc.*, vol. xxvii, p. 180.

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The chapters on Treatment of Abnormalities in position of the Teeth in "The Science and Practice of Dental Surgery," Edited by N. G. Bennett.

CHAPTER VII

Abnormalities in Position of Individual Teeth

(A) MAXILLARY INCISORS

(1) Separation of the First Incisors

Causes.—Separation of the maxillary first incisors is usually due to the attachment of the frænum of the lip to the mucoperiosteum posterior to the teeth, but occasionally this irregularity can be traced to the presence of a supernumerary tooth; while in rare instances a persistent frænum and a supernumerary tooth are both present. That the frænum acts as a cause of divergent first incisors is often overlooked, but that such is the case will readily be seen on an examination of irregularities of this class. In a few cases the cause is obscure, separation being apparently the result of growth of bone at the median suture. Slight rotation often accompanies separation of the first incisors.

Treatment.—Should the cause of the irregularity be removed before the eruption of the canines, the space between the first incisors will, as a general rule, become lessened without mechanical treatment, as the canines in erupting will exert lateral pressure sufficient to bring the incisors into proper position. Supernumerary teeth should therefore be removed, where necessary, at the earliest opportunity and the frænum should be cut.

The operation of dividing the frænum is easily performed as follows: The free edge of the frænum is seized with a pair of artery forceps and drawn forward; a V-shaped piece is then removed from it with a sharp pair of scissors, care being taken to cut the part away where it blends with the gum (a point of great importance). The part between the teeth should also be removed. A strip of lint should be kept between the cut surfaces until the wound has healed, an antiseptic mouth-wash also being given. Cases treated by division of the frænum are shown in figs. 259 to 262. No mechanical treatment was adopted. Division of the frænum, if carried out before the eruption of the canines, will be found to lead to excellent results, but in cases treated after the eruption of these teeth the benefit is not marked, although the space will tend to close slightly. Should the removal of the cause not prove sufficient to correct the deformity, the teeth can easily be approximated by mechanical methods.

A plate of the form shown in fig. 238 will be found useful. After the teeth have been brought together, it will be necessary to retain them in position by suitable means.

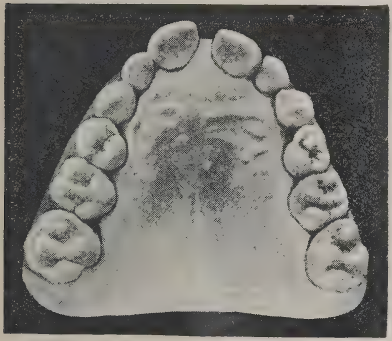

FIG. 259.—Case 1. Before treatment.

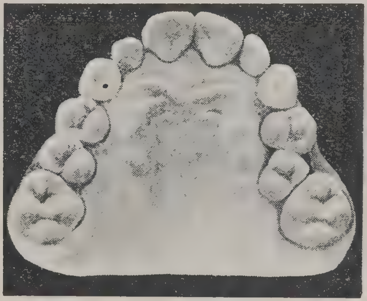

FIG. 260.—Case 1. After treatment.

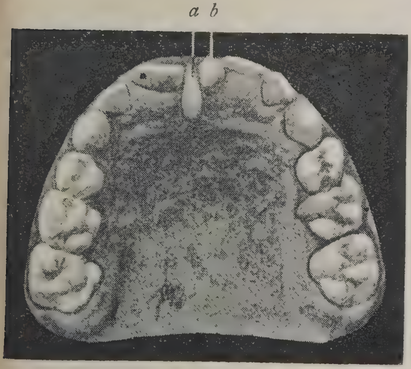

FIG. 261.—Case 2 (semi-diagrammatic). The separation of the first incisors was due to (*a*) the frænum, and (*b*) peg-shaped supernumerary tooth.

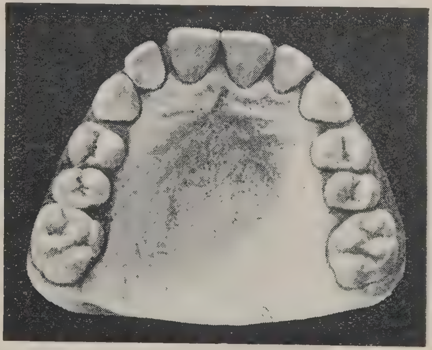

FIG. 262.—Case 2. After treatment.

(2) Displacement External or Internal to the Arch

Causes.—The displacement of an incisor external or internal to the arch may be due to the persistence of the deciduous predecessor (see p. 147). Where a maxillary incisor erupts so far out of line as to be outside the lower lip, the pressure of the lip will tend greatly to increase the amount of projection. The protrusion of a maxillary incisor may be due to irregularity of the mandibular teeth.

Thumb- or finger-sucking, if continued, will lead to protrusion of the incisors.

In a few instances the protrusion is traceable to the habit of constantly sucking the lower lip or tongue. The prolonged use of the baby comforter or "dummy" also leads to protrusion of incisors (see pp. 148 and 270). The presence of supernumerary teeth gives rise to cases of displacement which often present considerable difficulties in treatment. An example is shown in fig. 161.

The supernumerary teeth invariably develop on the palatal aspect of the arch and cause a displacement of the incisors forwards (see p. 117).

Treatment.—Teeth that erupt internal to the arch may be treated either by an upper plate with wires or wedges (see fig. 235), or by a lower plate with an inclined plane. The latter method is particularly useful where the maxillary teeth do not afford a firm hold for a plate.

When a tooth shows signs of erupting external to the arch it is usually sufficient to remove the deciduous tooth and leave the natural forces to complete the process of correction. But if the tooth falls outside the lower lip mechanical measures must be resorted to. After correction, it will be necessary to retain such teeth in position for from three to six months.

Where a supernumerary tooth is the disturbing influence, the tooth should be removed as soon as its presence is detected.

(3) Rotation

Causes.—Rotation of an incisor may arise from the persistence of a deciduous tooth, or from the presence of a supernumerary tooth. A slight tilting of the second incisors may often be traced to the canine developing in a slightly abnormal position. The frænum of the lip, in addition to causing separation of the first incisors, may be the cause of slight rotation of one or both teeth. The amount of rotation of the incisors may vary from an eighth to half a turn.

Treatment.—The first step is to remove the cause, if practicable. In some cases the supernumerary tooth may be high up on the palatal aspect. The removal of the tooth may cause considerable damage to the bone and also the misplaced incisor, and it is therefore better in such cases to leave the irregularity untreated. The rotation of a tooth may be accomplished either by *immediate* *torsion*, i.e., turning the tooth with forceps, or by *gradual torsion*, i.e., rotating the tooth by mechanical methods.

Immediate torsion.—This method saves time and avoids a plate, but on the other hand it involves the following risks:—

(*a*) Liability of the tooth to leave the socket (completely) during the operation.

(*b*) The risk of death of the pulp from strangulation of the vessels of the apex.

(*c*) Fracture of portions of the enamel from pressure of the forceps.

(*d*) Fracture of the root in cases where the end is twisted.

As a rule, immediate torsion should not be resorted to until the root of the tooth is complete, which usually occurs about the age of ten. Where there is reason to suspect that the root may be twisted, a radiogram should be obtained with the object of ascertaining its shape.

A model of the mouth should be taken before the operation, the tooth corresponding to the one which is to be rotated being cut off and then re-affixed to the model in the position which it will occupy after rotation. A thin metal splint should next be made, by the corrected model, to cover the lower third of the tooth to be operated on as well as the approximal teeth. This splint is applied by first drying the teeth and then fixing the splint in position with osteoplastic cement.

The operation of twisting the tooth should be performed with a pair of forceps which fits the tooth accurately. The blades should be covered with some such substance as thin lead foil, lint, or cotton-wool. W. H. Dolamore recommends the use of india-rubber between the blades at their division, the elasticity of rubber exerting a force in an upward direction. The tooth should be grasped firmly, and slowly rotated, steady pressure in an upward direction being maintained during the process of turning in order to overcome the tendency of the tooth to leave the socket. It is advisable to turn the tooth slightly more than is required. Immediately the operation is completed, the splint should be applied and retained in place for about a week. An antiseptic mouth-wash should be prescribed.

Before the operation is performed it is obviously essential to obtain sufficient space to allow of the necessary movement of the tooth. At times it is difficult to gauge the precise amount of space that will be necessary, and the direction of the root of the tooth to be turned should always be taken into account, as the tooth will not necessarily occupy the whole space.

Should the accident of complete removal of the tooth from its socket occur, the tooth must be cleansed in an antiseptic solution and replaced. Such teeth frequently remain alive.[1]

If the tooth after rotation shows signs of pulpitis, the gum should be painted with a counter-irritant, but if this fails to bring relief and the symptoms become aggravated the pulp cavity should be opened and the pulp removed. It is inadvisable to delay the removal of the pulp, as timely interference may prevent discoloration of the tooth substance, or, what is more serious, suppuration, which may eventually lead to loss of the tooth.

The gradual or mechanical torsion of a tooth can be carried out in a variety of ways, all of which depend upon the principle of two forces working in opposite directions. A favourite method is to fix to the tooth a band with soldered hooks at the mesial and distal angles. Elastic bands are stretched from the hooks to attachments in the vulcanite plate. Other methods might be enumerated, but they all depend upon employing two forces acting in opposite directions.

(4) Elongation

Cause.—Elongation of an incisor is usually the result of an accident.

Treatment.—Where the elongation is slight, the tooth may be cut down by means of carborundum wheels, care being taken to polish the cut surface thoroughly. In more severe cases, an endeavour may be made to force the tooth into the socket if it is desirable to shorten the tooth for æsthetic reasons.

(5) Displacement Upwards of an Incisor

Causes.—This irregularity is generally the result of injury, but it might result from mal-development.

Treatment.—A radiogram should always be obtained in order to ascertain the shape of the root of the tooth. If the root is normally developed and it is considered advisable to correct the deformity, treatment may be carried out:—

(*a*) By reducing the length of the approximal teeth.

(*b*) By bringing the tooth into place with forceps.

(*c*) By gradually bringing the tooth into place by mechanical appliances.

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[1] An interesting example of this was recorded by A. S. Underwood in the *Trans. Odonto. Soc.*, vol. xviii, p. 98.

Method (*a*) may be adopted when the displacement is slight, but it is more suitable for the treatment of the first incisors than for the treatment of the second incisors. With the first incisors a symmetrical appearance can be obtained by grinding down the cutting edge or rounding off the angles of the fellow tooth. With the second incisors reduction of the length of the approximal teeth will naturally give an asymmetrical appearance to the mouth, but this may of course be overcome by treating the incisors and canine on the other side of the mouth in a similar manner, but this plan is seldom advisable.

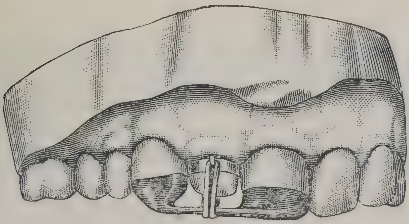

FIG. 263.[1]

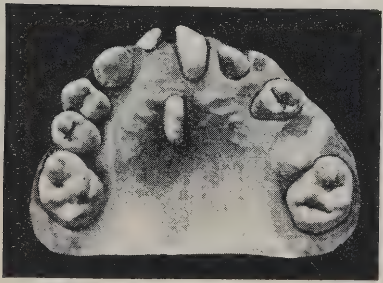

FIG. 264.

Method (*b*) may be adopted in cases of forcible displacement upwards, provided that the patient is seen at an early date after the accident.

Method (*c*) may be accomplished by the plan shown in fig. 263, the suggestion of C. L. Goddard. Caps connected by a wire are attached to the teeth approximal to the one to be regulated. To the latter tooth a band is adjusted, hooks being soldered to the labial and lingual surfaces. Traction force is obtained by an elastic band arranged as shown in the illustration.

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[1] From "Text-book of Operative Dentistry" (Kirk).

Where the root of the tooth is abnormal in direction, method (*a*) only should be adopted.

(6) Total Displacement of the Incisors

Incisors may be transposed, that is, occupy the site of another tooth. For instance, the first and second incisors may change positions, or the second incisor may occupy the position of the canine. Cases of transposition do not call for treatment. The incisors may be completely displaced, as shown in fig. 264, and it is needless to say that the only treatment for such abnormalities is extraction. Occasionally the incisors erupt high up in the alveolar arch with the cutting edges directed forward. Such teeth are usually "dilacerated," and endeavours to bring them into place would prove futile. Extraction is the only remedy. Niemeyer[1] records a case in which the maxillary right first incisor erupted through the lip in a woman about sixty years of age; and Salter[2] mentions a case where the second incisor erupted in the nostril.

(B) MANDIBULAR INCISORS

The mandibular incisors may erupt internal or external to the arch. These conditions are usually associated with persistence of deciduous teeth, and when this is the case the obstructing tooth should be removed. No further treatment is as a rule necessary, the pressure of the tongue on the one hand and of the lips on the other usually being sufficient to bring the tooth into line. In a few cases the incisor may occlude outside the maxillary incisor; under these conditions the mandibular tooth must be retracted or the maxillary tooth pushed out. Total displacement of the mandibular incisors is very rare.

(C) MAXILLARY CANINES

The eruption of the maxillary canine external to the arch may be associated with persistence of the deciduous tooth, but as a rule this irregularity is the result of lack of space arising from the forward movement of the premolars and molars. The early extraction of the second deciduous molar may be followed by a forward movement of the first permanent molar, and the second premolar in erupting forces forward the first premolar. If, however, the canine erupts before the second premolar, the first premolar is driven back by the canine and the second premolar erupts in a misplaced position.

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[1] *Deutsche Monatsschrift für Zahnheilkunde.*

[2] "Dental Pathology and Surgery," S. J. Salter, p. 51.

Eruption of the canine internal to the arch is usually due to some developmental defect as pointed out on p. 118.

For the methods of treating the above irregularities, see p. 246.

Partial eruption of the canine occurs occasionally. An effort may be made to force the tooth to erupt, but success is by no means certain. An appliance for this purpose is figured by Essig.[1]

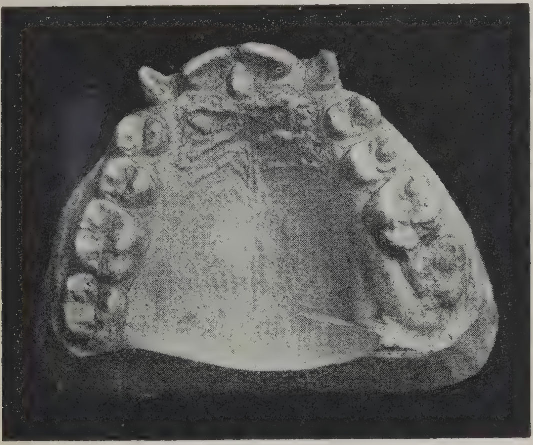

FIG. 265.

A band is cemented to the first premolar. To this band a tube is soldered. Into this tube a piece of wire is fixed which extends across the space and under the cutting edge of the second incisor. A stud is fixed into the canine tooth and traction applied by means of elastic.

In all cases where a permanent canine erupts late, a radiogram should be obtained, and if there is no indication that the tooth is coming into correct position, or the root shows signs of being twisted, the tooth should be removed and the deciduous canine retained.

Complete Displacement.—The maxillary canine is more frequently " transposed " than any other tooth, that is, occupies the normal position of another tooth. It may be found usurping the place of the second incisor, or of the first premolar and occasionally of the second premolar. In one recorded case[1] the left canine erupted posterior to the second premolar, the first permanent molar having been extracted at an early age. The canine is totally displaced from the arch more frequently than any other tooth. The misplaced tooth in these cases often lies dormant and causes no inconvenience, but, should it erupt, extraction is the best remedy. A unique case in which a deciduous canine was developing within the left orbit has been recorded by J. W. Cousins.[2] The patient was two years of age and there was a hard swelling located just within the left orbit. On the growth being detached from its surroundings, the crown of a deciduous canine was found enclosed in a sac, the root of the tooth being attached to the orbital plate by fibro-cartilage.

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[1] " Text-book of Prosthetic Dentistry."

Misplaced canines may lead to troublesome irregularities of the teeth present in the arch. An example is shown in fig. 265. The second incisors have been rotated and tilted owing to the pressure of the canines. Under such conditions, the canines may be removed and correction of the misplaced teeth carried out.

(D) MANDIBULAR CANINES

Irregularities of the mandibular canines from causes other than crowding are rare. In the case shown in fig. 180 the deciduous canine is in position and the permanent canine has erupted internal to the arch. The misplaced tooth was removed.

An interesting example of a misplaced mandibular canine was recorded by C. Truman.[3] The tooth appeared under the chin, the presence of a sinus having apparently caused the deviation. After its removal, a premolar made its appearance in the same position. A similar case was recorded by D. Whittles.[4]

Complete displacement of the mandibular canine has been referred to on p. 130.

(E) PREMOLARS

Abnormalities in the position of the maxillary and mandibular premolars are usually the result of early extraction of the second deciduous molar. The first premolar erupts in correct position with the second premolar misplaced internal to the arch. More rarely, both the teeth are involved in the irregularity, as seen in fig. 266. Irregularly placed premolars are best treated by extraction provided that both the approximal teeth can be saved. If, however, one of the approximal teeth is unsavable it should be removed and the misplaced premolar trained into position. In a case similar to that shown in fig. 266, one of the premolars should be removed, and, in choosing between them, the judgment should be guided by their relation to the opposing teeth and by the degree of rotation.

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[1] Hopewell-Smith, *Brit. Dent. Journ.*, April 15, 1914.

[2] *Journ. Brit. Dent. Assoc.*, vol. viii, p. 294.

[3] *Trans. Odonto. Soc.*, vol. xxiii, New Series, p. 34.

[4] *Journ. Brit. Dent. Assoc.*, December, 1901.

Misplacement of the premolar may be associated with persistence of the second deciduous molar. An example is seen in fig. 266; in this case the outstanding premolar should be removed. The probable cause of this irregularity was discussed on p. 124.

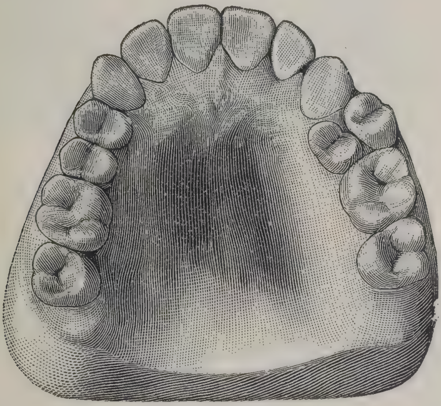

Fig. 266.

Occasionally the premolars are completely rotated, the external cusp being placed towards the palate. This irregularity is at times symmetrical.

Transposition of the maxillary canine and first premolar may occur. Complete displacement of the premolars from the arch is rare.

(F) MOLARS

The irregularities in position of these teeth have already been described on pp. 132 to 135.

CHAPTER VIII

Abnormalities in Position of Several Teeth—General Crowding

In cases of general crowding of the teeth the irregularity varies from a slightly crowded arrangement of all the teeth to the extrusion from the arch of one or several teeth. The general causes of abnormalities in position of the teeth have been discussed in Chapter V; here it may be stated that crowding of the teeth is to be traced to a reduction in the growth of the jaw due to inherent or acquired causes and to the self-adjusting movements of the teeth where some of them have been prematurely lost.

(A) MORBID ANATOMY AND PATHOLOGY

The positions which teeth assume in the crowded arch depend upon several contingencies which may now conveniently be referred to. The direction in which a tooth erupts is in all probability identical with the line of the long axis of the tooth in the crypt, and that being so, it follows that the position of a tooth in its crypt is an important factor in determining the position which it will assume in the arch. Normally, the developing permanent teeth in the maxilla are arranged as follows: The crown of the first incisor slopes slightly forwards; the permanent second incisor lies in a plane posterior to that of the first incisor, the distal border being in close proximity to the anterior root of the first deciduous molar; the permanent canine is high up in the bone and lies in a plane anterior to that of the second incisor; the premolars are embraced by the roots of the deciduous molars (fig. 267). In the mandible a somewhat similar arrangement exists. With a diminution of space available for the teeth, it necessarily follows that any irregularity in position of the teeth in their crypts becomes more marked. The relative positions as seen in the normal may remain, the second incisors being placed more inwards and nearer to the middle line with the canines more outwards, or the *normal relative positions may be disturbed*, as shown in the following specimens:—

The skull of a child of five years six months is shown in fig. 268.

Several of the deciduous teeth have been lost, but those that remain are slightly crowded. In the left maxilla the positions of the first and second incisors in relation to one another are normal; the first incisor, however, is a little tilted on its long axis. In the right maxilla the first incisor is tilted so that the mesial angle is forward,

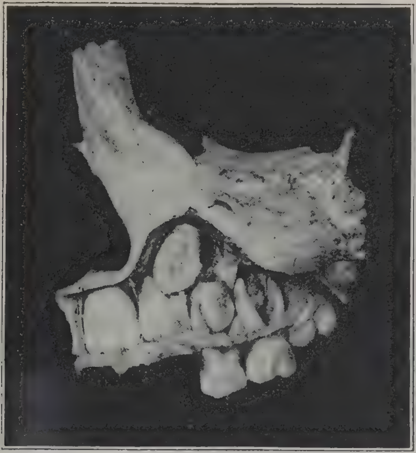

FIG. 267.—Left maxilla of a child six years of age, to show the position of the permanent teeth.

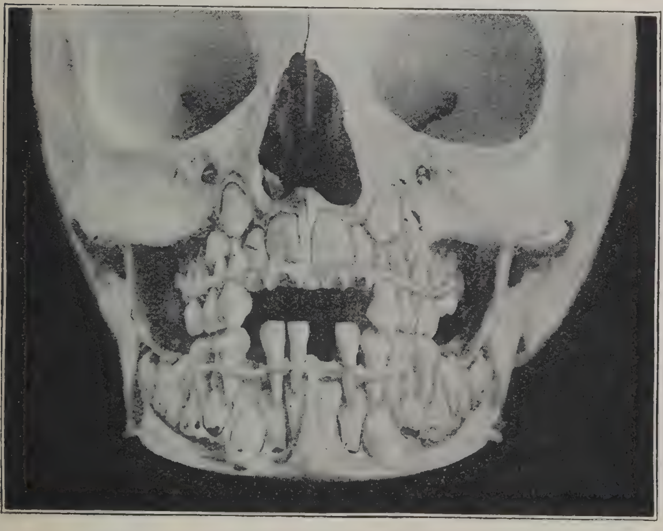

FIG. 268.—Skull and mandible of a child aged five years six months, showing irregularity in position of the maxillary right incisors.

and the second incisor overlaps the distal corner of the labial surface. The sutures are closed in their distal halves.

Fig. 269 reveals a considerable departure from the normal in the left maxilla. The first incisor is rotated so that the mesial angle looks almost directly forwards; the second incisor is also rotated, but to a lesser extent, and overlaps the first incisor. In the right maxilla the first incisor is rotated, the distal angle being directed forwards; the second incisor is overlapped by the first incisor.

In the next specimen (fig. 270), five years nine months, the maxillary deciduous incisors have been removed to show the position of the permanent teeth. The maxillary first incisors have their mesial borders rotated a little forward, and the second incisors overlap their distal corners. The deciduous teeth, when in position, are bent a little inwards, and there is slight crowding. The sutures are partially filled up in their outer quarters, the right a little more than the left. In connection with the closure of the sutures it is interesting to note that the irregularity of the permanent teeth is more marked on the right side.

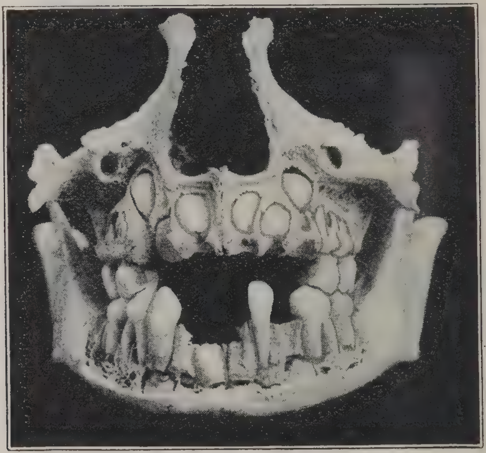

FIG. 269.—In this specimen there is marked irregularity in the position of the developing maxillary incisors.

In fig. 271 the maxillary right second incisor slightly overlaps the first incisor and the mesial angle is tilted forward. On the left side the second incisor slightly overlies the first, the latter tooth being a little rotated. The maxillary deciduous incisors are missing, but the mandibular teeth show good spacing. The inter-canine width is slightly above and the inter-molar width equal to the

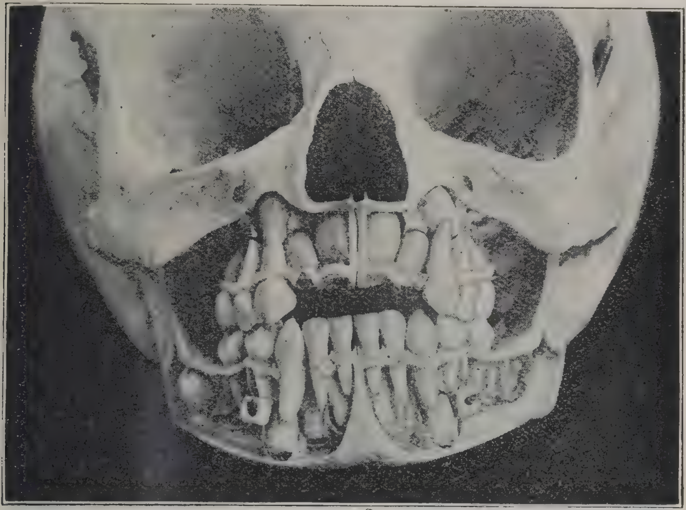

FIG. 270.—Skull and mandible of a child aged five years nine months, with the deciduous incisors removed to show the irregularity in position of the developing maxillary incisors.

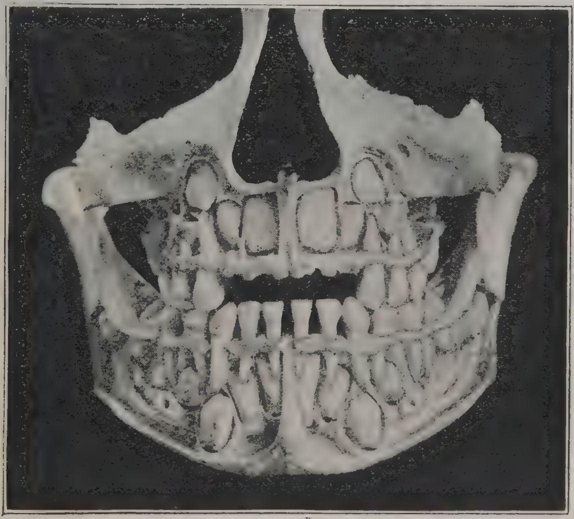

FIG. 271.—Skull and mandible of a child about six years of age, showing irregularity in position of the developing maxillary incisors.

normal average. The suture on the left side runs near to the deciduous canine socket; the right suture terminates forward of the deciduous canine.

Another modification in the position of the permanent incisors is shown in fig. 272. The maxillary first incisors are placed with their long axes towards the mid-line and the canines lie with the crowns pointing away from the mid-line. The opening of the anterior nares is small, and the whole specimen conveys the impression that there is a want of growth of the body of the maxilla.

Fig. 273 is from the skull of a child between six and seven years of age. The maxillary incisors are distinctly crowded; the right first incisor is partially rotated and is overlapped by the second incisor; the left first incisor has a distinct slope away from the mid-line and overlaps the second incisor. The arch of the deciduous teeth is well formed, the teeth are well spaced; the maxillary-premaxillary sutures are distinctly closed in their distal halves.

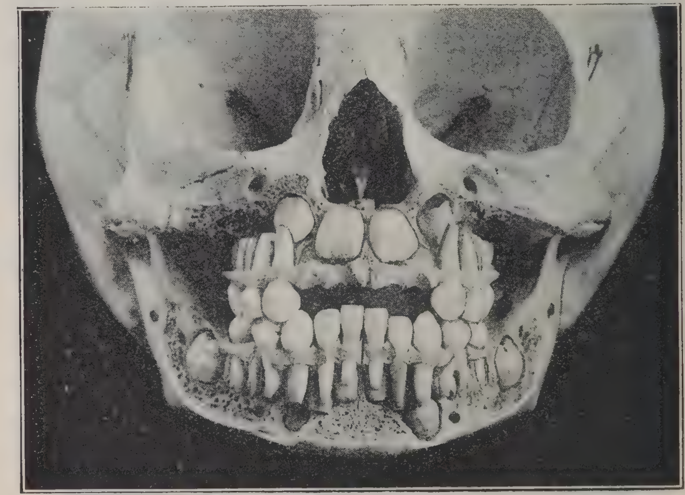

Fig. 272.—Skull and mandible of a child about five years of age, showing considerable irregularity in the position of the developing maxillary incisors and canines.

The Order of Eruption is an important factor in determining the character of an irregularity, and this is clearly shown in cases of early loss of the second deciduous molar. When the teeth appear in their normal order the canine erupts after the second premolar; hence, if there is insufficient room in the arch, the canine will be the principal disturbing factor. If there is a fair interval between the second incisor and the first premolar the canine will force its way into the arch, causing disturbance in the position of the incisors, but if the interval is slight the result will be the exclusion of the canine which will erupt external to the arch. The pressure of the canine, *even when excluded from the arch*, may force the incisors into irregular positions.

Should the canine erupt before the second premolar, the disturbance in the position of the anterior teeth will be less noticeable. The incisors, canine, and first premolar will erupt in a fairly regular manner, the premolar being forced towards the first molar. If the space between the premolar and first molar is slight, the second premolar will erupt internal to the arch and cause little disturbance. On the other hand, if the interval is nearly normal, the second premolar in erupting will, in all probability, cause displacement inwards of the first premolar and so produce a type of saddle-shaped arch.

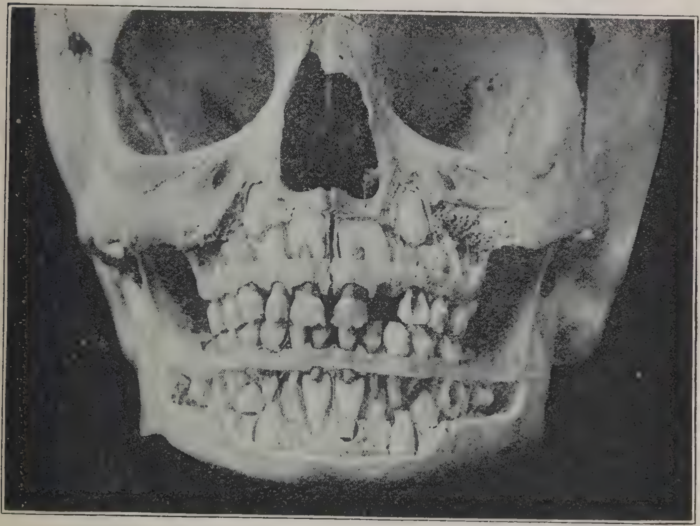

FIG. 273.—Skull and mandible of a child between six and seven years of age. The maxillary incisors are developing in abnormal positions.

The type of irregularity also varies with *the cause interfering with the growth of the jaws*. In cases where "adenoids" have been present before the age of six the interference with the growth of the premaxillæ will lead to crowding of the first and second incisors, and the roots of the second incisors will lie with their apices directed towards the median line. The canine also, owing to the want of development of the anterior nares, will lie too near to the median line, with the result that, when erupted, the root will cover a small portion of the upper part of the second incisor root. This point is of practical importance when the treatment of crowded incisors is under consideration. Where the main interference in the growth has occurred in the molar region, the incisors will generally erupt in a regular curve, and the principal irregularity will be posterior to the premolars and canine, the irregularity being shown in an increased backward direction of the occlusal surfaces of the molars.

In order that the conditions which exist in cases of "crowded arches" may be fully appreciated, it is essential that a careful study should be made of morbid anatomy specimens. Unfortunately our dental museums possess few such specimens, but there is a useful collection in the Museum of the Royal College of Surgeons of England, and specimens in this collection will be described.

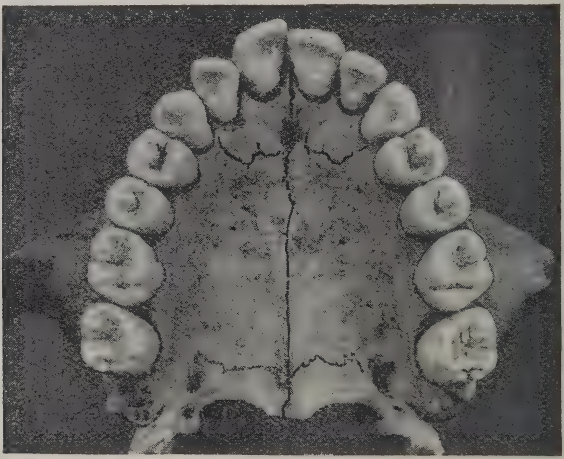

FIG. 274.[1]—Maxillæ showing irregular arrangement of the incisors. R.C.S. Odonto. Series.

The maxillæ shown in fig. 274 are from a male aged 18 years. The teeth are arranged in an arch of the shape of the normal English type. The width across the first premolars is 26 mm.; between the canines 22·3 mm. The incisors are slightly crowded;

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[1] The positions of the sutures in this and the following specimens are indicated by dark lines.

the right teeth are rotated, the first incisor overlapping its fellow of the opposite side.. The maxillary-premaxillary suture runs on the right side to the mesial aspect of the canine and on the left side to the distal aspect of the canine. This is instructive as the greater degree of crowding is on the right side.

A view of the left incisors and canine is shown in fig. 275. The crowns of these teeth slope slightly forwards, the mesial angle of the first incisor being beyond the mid-line.

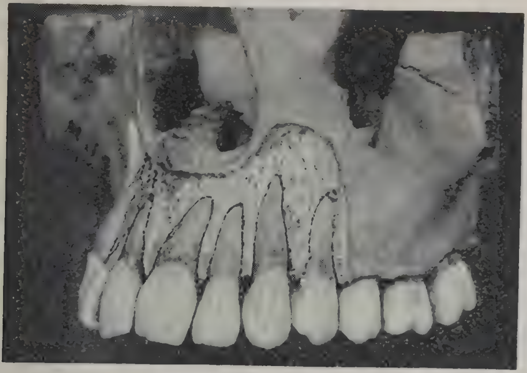


Fig. 275.—Side view (left) of the specimen shown in fig. 274.

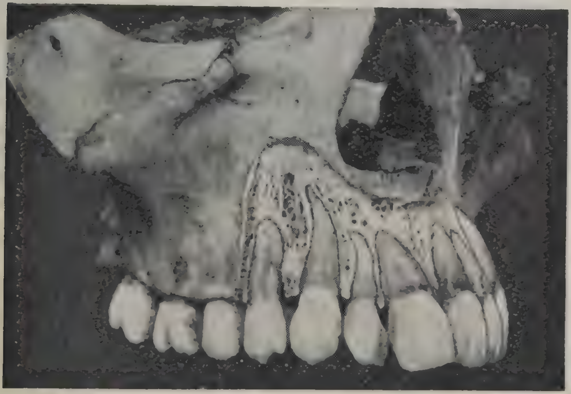


Fig. 276.—Side view (right) of the specimen shown in fig. 274.

The right side (fig. 276) presents the following instructive features:—

(1) The canine has the crown placed in a slightly backward direction.

(2) There is marked rotation of the second incisor, the mesial border looking inwards.

(3) The crown of the first incisor slopes towards the opposite side, the mesial angle overlapping the left first incisor.

(4) The root of the second incisor is overlapped by that of the first incisor.

These facts indicate a lack of growth of the premaxillæ.

An extreme degree of crowding in the incisor region is seen in the specimen illustrated in fig. 277. The width of the arch is:—

(*a*) Between the first premolars, 25·2 mm.

(*b*) Between the canines, 20·5 mm.

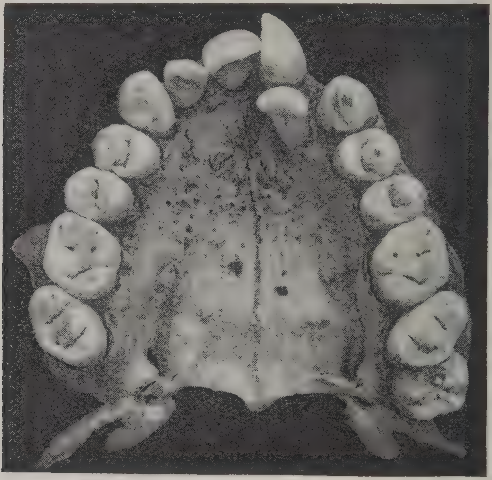


Fig. 277.—A specimen showing marked irregularity in position of the left incisors.

R C.S. Odonto. Series.

On the right side, the crowns of the canine and the incisors incline towards the mid-line; the mesial angle of the second incisor is covered by the distal angle of the first incisor, while the latter tooth has the mesial angle well across the mid-line. On the left side, the crown of the canine has a marked forward inclination; the first incisor is rotated so that the mesial border looks directly forwards; the second incisor is placed internal to the arch and is situated immediately posterior to the root of the first incisor. Here again the position of the maxillary-premaxillary suture is instructive. On the right side it runs towards the mesial aspect of the canine; on the left side it appears to run directly up to the mesial aspect of the second incisor.

The other points to be noted about the specimen are:—

(1) The regular arrangement of the premolars and the first and second molars.

(2) The abnormal shape of the second molars, these teeth appearing to be compressed from before backwards.

(3) The left third molar has erupted high up in the tuberosity, the occluding surface looking well backwards.

(4) The right third molar has not developed.

The irregularity of the incisors is probably due to underdevelopment of the premaxilla, and the malposition of the third molar to insufficient backward growth of the maxilla, a condition often associated with "adenoids."

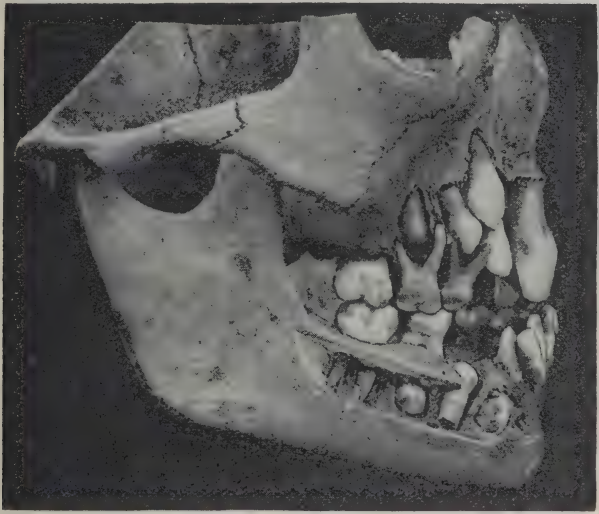


Fig. 278.—Skull and mandible showing crowding of the incisor teeth. (Right side.)

An example of crowding of the anterior teeth in a child aged seven years three months is shown in figs. 278 to 281.

A profile view of the specimen shows that the maxillary first incisors have partially erupted and that the left tooth is inclined inwards. The maxillary second incisors are situated well posterior to the first incisors, the canines overlapping their anterior aspects; this is particularly noticeable on the left side.

The palatal view, fig. 280, shows that the premaxillæ are very poorly developed and that the anterior part of the palate presents the pushed-up appearance so characteristic of the adenoid palate. The first permanent molars have assumed a normal position in the arch and the second molars appear to have ample room for development.

In the mandible, fig. 281, there is a crowded arrangement of the incisors, the right second incisor lying posterior to the first incisor.

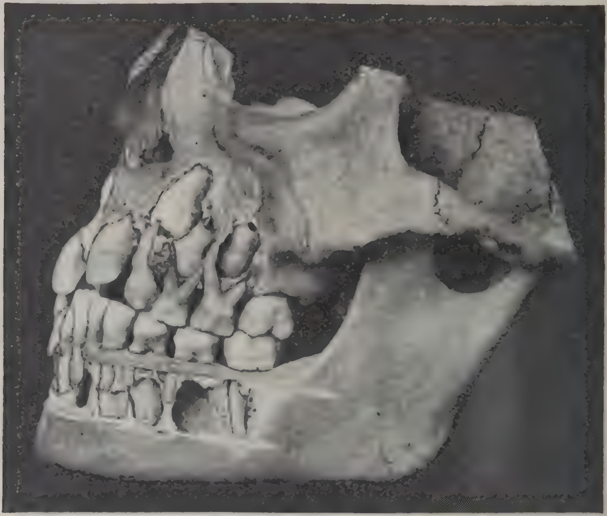


Fig. 279.—Skull and mandible showing crowding of the incisor teeth. (Left side.)

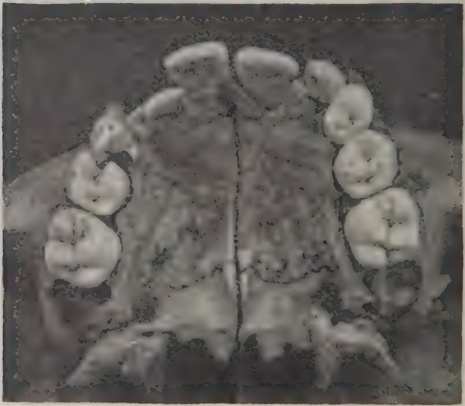


Fig. 280.—Palatal view of the specimen shown in figs. 278 and 279.

Side views of the jaw are illustrated in figs. 278 and 279. On the left side one of the premolars has unfortunately been lost; on the right side, however, they are all present so that a good idea can be obtained of the general crowding of the maxillary teeth. The occlusion of the first permanent molars is normal, and there seems to be ample room for the growing premolars. The crown of the first premolar is in close proximity to the second incisor and the anterior aspect is in contact with the crown of the canine. The crowding in this specimen seems to be due to lack of growth of the premaxillæ.

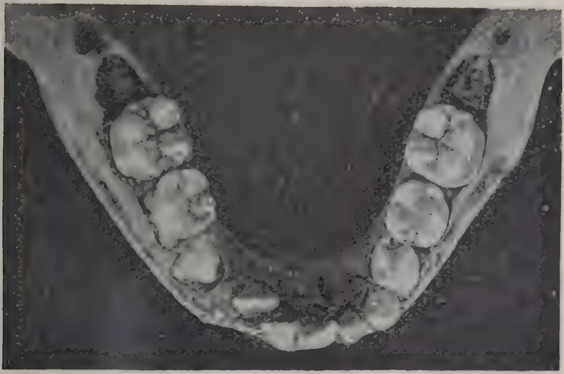


FIG. 281.—View of the mandibular teeth of the specimen shown in figs. 278 and 279.

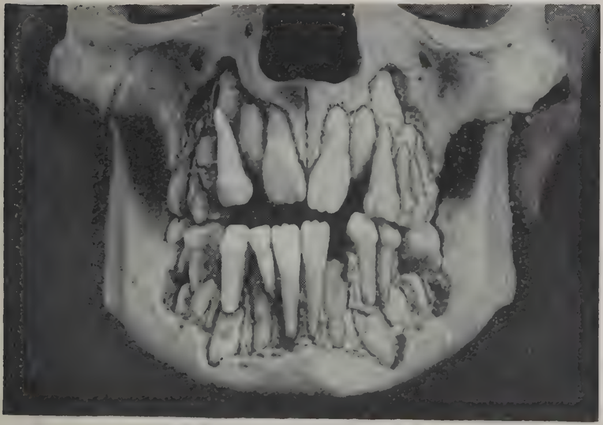


FIG. 282.—Specimen showing general crowding of the teeth. R.C.S. Odonto. Series.

The specimen from a female child aged seven years eight months, shown in figs. 282 to 285, is a good example of marked crowding of the teeth from undergrowth of the maxillæ.

The palate, fig. 283, is distinctly small and towards the front shows the curious pushed-up appearance so often seen in those who have suffered from "adenoids" in the early years of life. There is also a definite asymmetry of the dental arch, the right side diverging more than the left. A view of the left premolars and molars is shown in fig. 284.

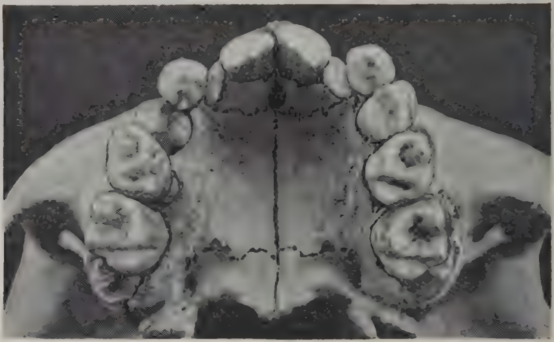


FIG. 283.—Palatal view of the maxillary teeth of the specimen shown in fig. 282.

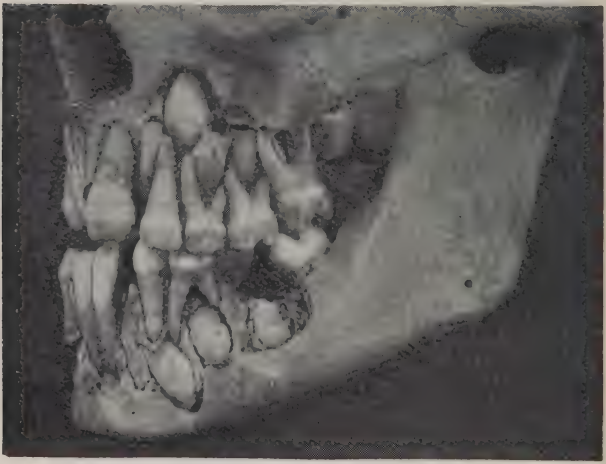


FIG. 284.—Side view (left) of the specimen shown in fig. 282.

The features to be noted are:—

(1) The normal occlusion of the first deciduous molars.

(2) The slight forward movement of the mandibular first molar owing to early loss of the second deciduous molar.

(3) The extreme backward direction of the occlusal aspect of the maxillary first molar.

(4) The crowded arrangement of the developing maxillary premolars. The anterior buccal root of the first permanent molar is almost in contact with the second premolar.

(5) The definite inward direction of the second premolar.

(6) In the mandible the apparently ample space for the developing premolars.

On the right side, fig. 285, with the loss of the first deciduous molar, the second deciduous and first permanent molars have moved forward, the occlusion being flush. The forward movement of the first permanent molar has allowed this tooth to assume a direction in the arch more closely approximating the normal, but the anterior buccal root is still too close to the second premolar. Want of room has caused the second premolar to assume an inward direction. In the mandible there appears to be ample space for the developing teeth.

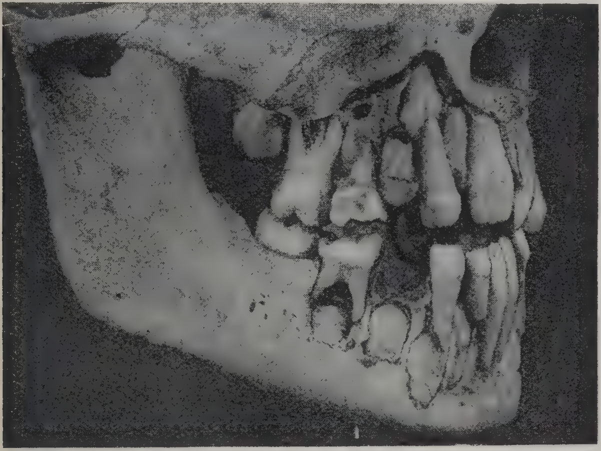


Fig. 285.—Side view (right) of the specimen shown in fig. 282.

The view of the anterior aspect of the specimen, fig. 282, shows that the maxillary incisors are erupting with a distinct inward inclination of the crowns. The teeth are arranged in a crowded manner shown by the rotation and overlapping of the teeth. On the left side, fig. 284, the canine is high up in the bone between the second incisor and the first premolar, the canine having rotated in order to adapt itself to the diminished space. On the right side, fig. 285, the rotation of the maxillary canine is more marked.

In the maxillæ and mandible of a male fourteen years of age, shown in figs. 286 to 289, we are able to study the morbid anatomy of a type of general crowding frequently seen in practice.

The general direction of the crowns of the maxillary teeth, fig. 286, is distinctly outwards; the incisors are crowded; the deciduous canines are still in place; there is clearly insufficient room for the permanent canines; the second molars are partially erupted with the occluding surfaces looking well backwards.

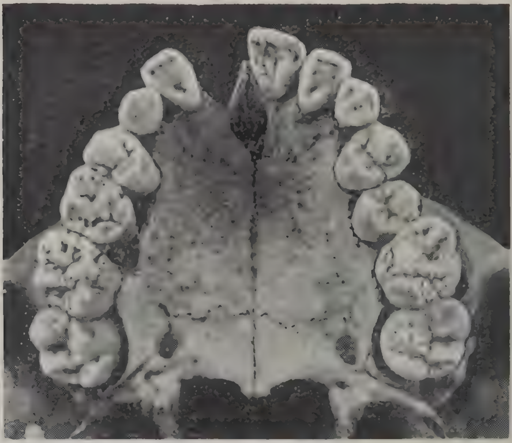


Fig. 286.—Maxillæ showing general crowding of the teeth.

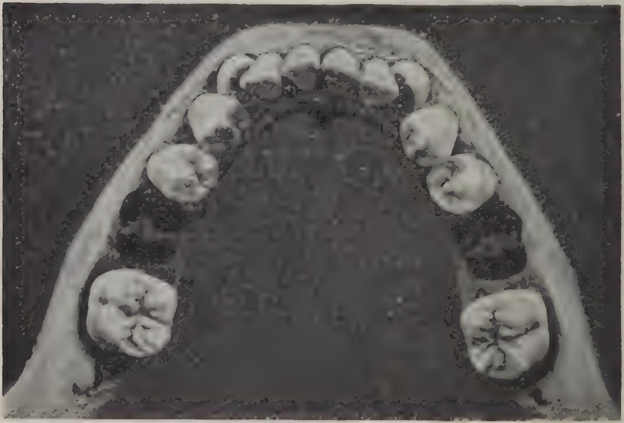


Fig. 287.—View of the mandibular teeth of the specimen shown in fig. 286.

In the mandible, fig. 287, the crowns of the teeth have a decided inclination inwards, the result being that the size of the arch is reduced and there is consequently insufficient room for the canines which are erupting in an abnormal position.

The occlusion of the premolars is normal; the erupting canines are pressing on the distal aspects of the second incisors; the maxillary right second premolar has not erupted and is placed in a decidedly abnormal position, the crown being directed outwards. The retarded eruption and irregular situation of the second premolar are probably due to sepsis in connection with the deciduous molar, a carious cavity being present on the mesial aspect. The roots of the deciduous molar show only a slight degree of absorption (figs. 288 and 289).

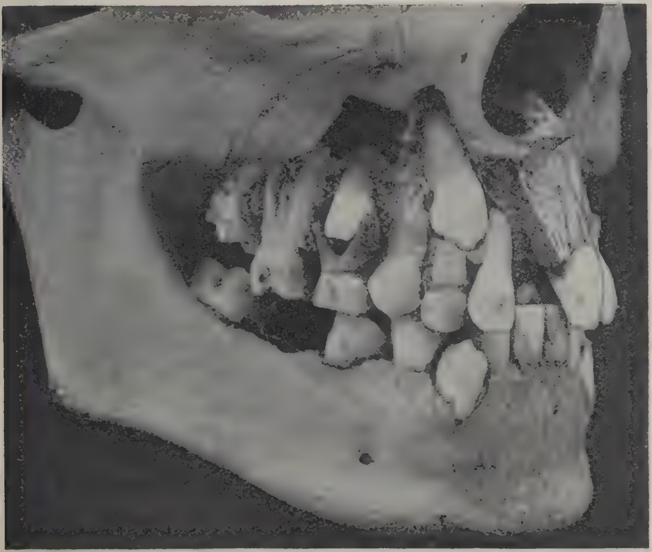


Fig. 288.—View showing the occlusion of the right premolars and molars of the specimen shown in figs. 286 and 287.

The irregularity of the teeth is to be traced to the restriction of the area available for their development, caused by the defective growth of the maxillæ after birth. The crowding is most marked in the incisor and molar regions, that is, the parts of the bone where most growth occurs after birth. The irregular arrangement of the teeth is probably produced in the following manner:—

(*a*) Deficient growth of bone at the suture between the pre maxilla and maxilla has resulted in (1) diminution in size of the premaxilla, and (2) diminished growth of bone in the region of the deciduous canine.

(*b*) The dwarfed premaxilla led to a modification in the position of the developing permanent incisors, the second incisor being tilted, the root end of the tooth passing towards the middle line.

(*c*) The left first incisor in the process of eruption, owing to lack of space, was deflected slightly to the opposite side, its backward movement being resisted by the deciduous second incisor.

(*d*) The second incisor has erupted in the line of the long axis of the tooth as placed in its crypt, its abnormal direction being subsequently accentuated by the position of the developing canine.

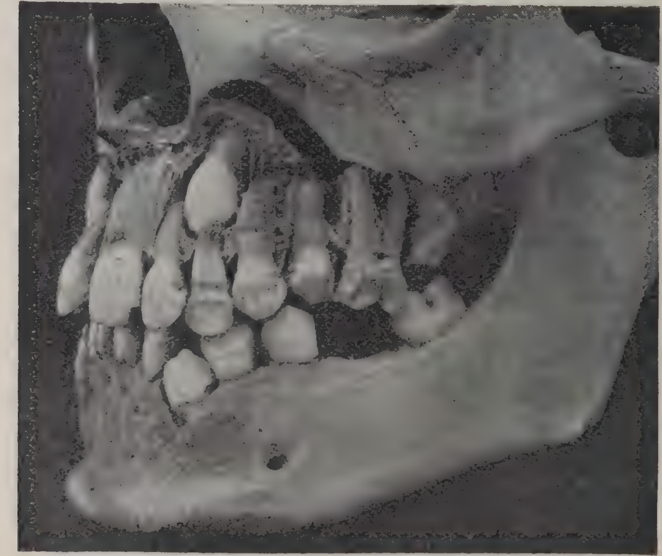


FIG. 289.—View showing the occlusion of the left premolars and molars of the specimen shown in figs. 286 and 287.

(*e*) The molars, developing in a crowded condition, will have a distinct tendency to move forward when resistance to that movement can be overcome. The loss of the first deciduous molar weakens the resistance and the first permanent molar commences to move forward, pushing before it the second deciduous molar. The first premolars, finding the space for development inadequate, rotate; the right premolar has gained some space by occupying a carious cavity on the mesial aspect of the second deciduous molar. With the loss of the second deciduous molar the resistance to the forward movement is still further reduced, and the first molar takes full advantage of this opportunity to move forward, as the specimen shows. The space between the anterior border of the first molar and the distal angle of the deciduous canine is 14 mm. on the left side compared to 15·5 on the right side. The forward movement of the first molar on the left side has lessened the space for the second premolar, which is being gradually driven internal to the arch.

(*f*) The crowding of the anterior teeth in the mandible is the natural result of the narrow arch in the maxilla. The teeth have been brought into a narrowed arch and have necessarily encroached upon the space for the canines, the last of the successional teeth to appear.

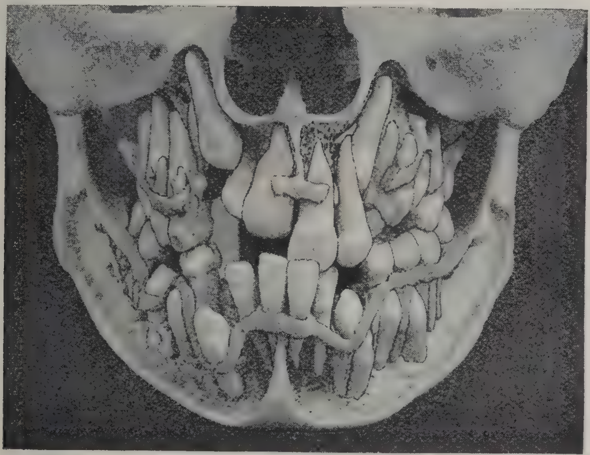


Fig. 290.—Skull and mandible of a child eight years six months showing general crowding of the anterior teeth.
R.C.S. Odonto. Series.

The primary cause of the irregularity seems clearly to be the defective development of the body of the maxilla.

An example of general irregularity of the anterior teeth is shown in the skull and mandible illustrated in figs. 290 to 294. The age of the child was eight years six months.

On the left side, fig. 291, the occlusion of the first permanent molars is normal; the maxillary first incisor has erupted internal to the bite of the mandibular tooth, which in its turn has been driven slightly forward; the maxillary second incisor has the crown tilted backwards; the crown of the canine has a marked slant towards the mid-line and is in contact with the posterior aspect of the root of the second incisor; the maxillary premolars are erupting with a distinct inward inclination; the mandibular canine and premolars are normal in position.

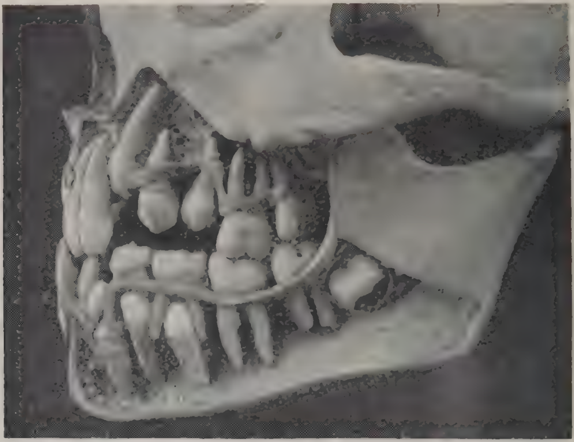


Fig 291.—View of the left premolars and molars of the specimen shown in fig. 290.

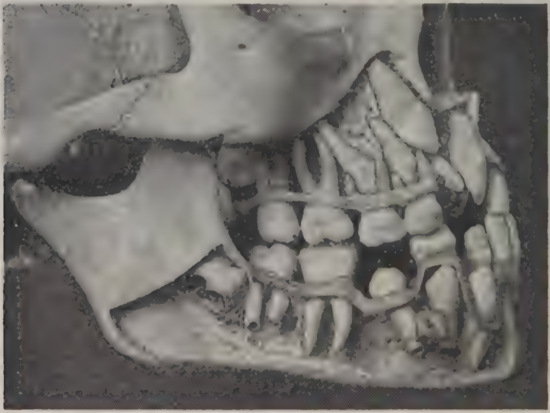


Fig. 292.—View of the right premolars and molars of the specimen shown in figs. 290 and 291.

On the right side, fig. 292, in the maxilla, the first incisor is not fully erupted and is slightly rotated, the mesial angle looking backwards; the second incisor is erupting behind the first incisor; the root is directed upwards, backwards and inwards, so that a marked space exists between it and the root of the first incisor; the crown of the canine is situated anterior to the second incisor and is erupting with a definite slope towards the median line; the second premolar has the root directed backwards, the distal aspect lying in contact with the anterior buccal root of the first molar.

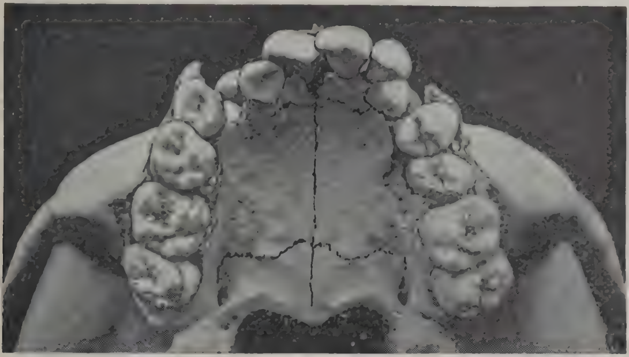


Fig. 293.—Palatal view of the maxillary teeth of the specimen shown in figs. 290 to 292.

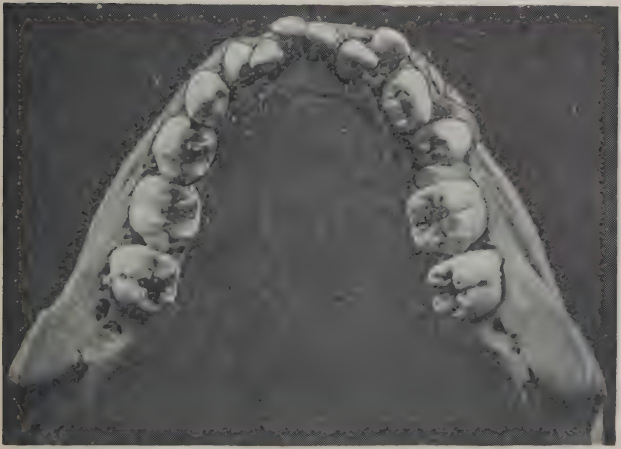


Fig. 294.—View of the mandibular teeth of the specimen shown in figs. 290 to 292.

In the mandible, the canine is displaced outwards; the first premolar is slightly rotated and the crown has an outward inclination; the second premolar has the crown looking backwards and there are spaces between it and the approximal teeth. The first molar does not belong to the specimen.

A palatal view of the maxilla, fig. 293, shows that the premaxillæ are quite small, with the suture between them and the maxillæ still open. The anterior nares are well developed.

The irregularity in this specimen would appear to be due to deficient growth of the premaxillæ.

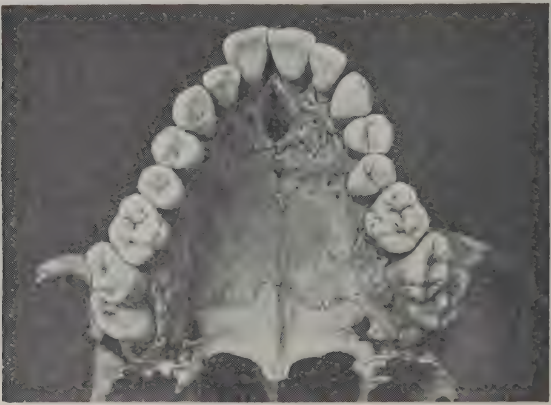


FIG. 295.—Palatal view of a crowded arch in an adult.

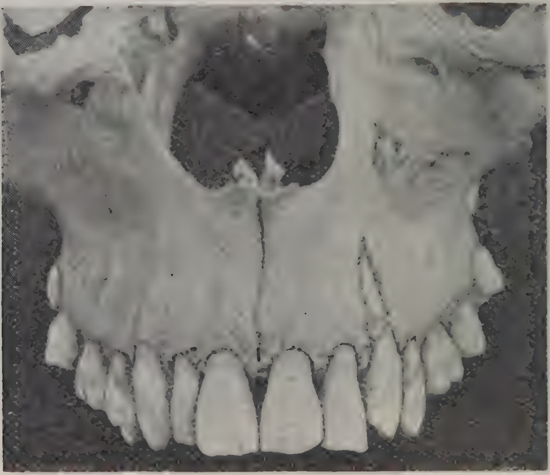


FIG. 296.—Anterior view of the specimen shown in fig. 295.

The specimen shown in fig. 295 is a good example of a crowded arch. The incisors are crowded; there is marked contraction across the region of the first premolars and canines; the second and third molars are misplaced.

Viewed from the front (fig. 296) the maxillæ show a pinched appearance; the malar process bends downwards at the junction with the malar bone. Contrast this specimen with that shown in fig. 297 where the teeth are practically normal in position. The facial surface of the bone is well developed and the malar process

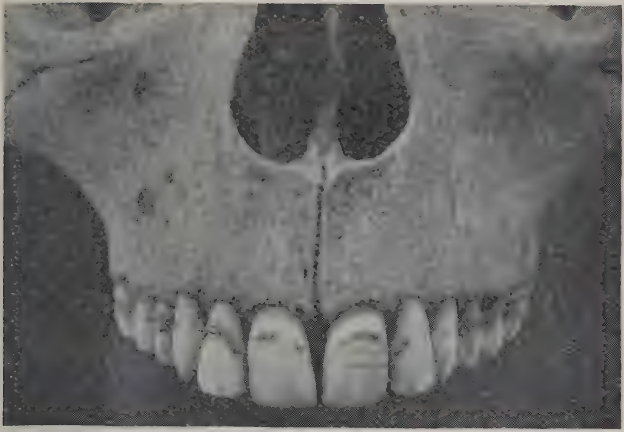


FIG. 297.—Normal maxillæ.

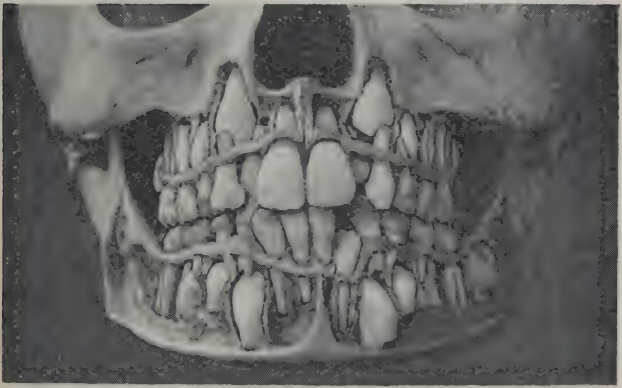


FIG. 298.—Skull and mandible of a child showing crowding of the anterior teeth.

takes a bold upward sweep. The capacities of the sinuses in the abnormal specimen are—right 90 and left 130 cubic millimetres; those of the normal specimen, although of an individual only sixteen years of age, are 245 and 205 cubic millimetres.

The skull with mandible of a child about seven to eight years of age shown in fig. 298 is a good example of crowding of the incisor teeth associated with an abnormal occlusion of the premolars and molars, and is typical of many cases seen in practice. A palatal view of the maxilla is shown in fig. 299.

The points to be noted are:—

(1) The narrowing of the arch across the region of the first deciduous molars.

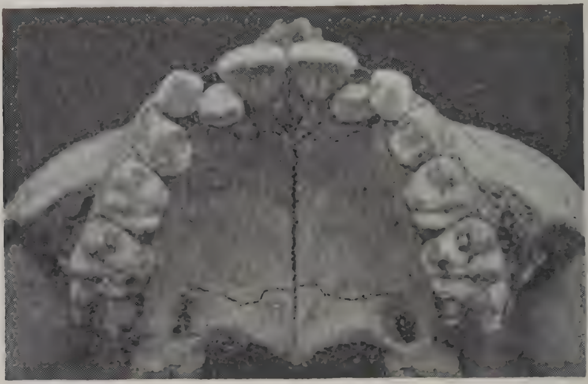


Fig. 299.—Palatal view of the specimen shown in fig. 298.

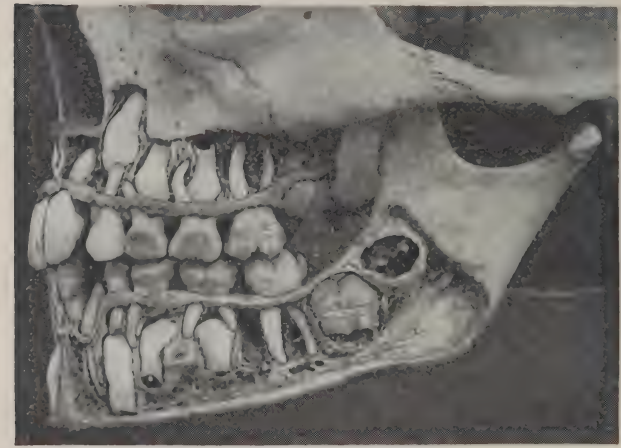


Fig. 300.—View of the left side of specimen shown in fig. 298.

(2) The crowded arrangement of the incisors, the second incisors being placed internal to the arch.

(3) The small size of the premaxillæ.

(4) The presence of a suture in each premaxilla, suggesting that the bone has arisen from two centres. The sutures between the

premaxillæ and maxillæ skirt the distal aspect of the sockets of the second incisors, and, towards the outer ends, are distinctly filled up, on the left side the suture being completely obliterated in one place. The sutures in the premaxillæ run towards the mesial aspects of the second incisors.

The occlusion of the premolars and molars is abnormal (figs. 300 and 301), the maxillary teeth being in advance of their normal relationship with the mandibular teeth. The maxillary first molar appears to be implanted in a normal position, the occluding surface looking downwards and slightly backwards and outwards. The premolars are in normal positions.

The positions of the anterior teeth are shown in fig. 298. In the maxillæ, the deciduous canines are less than 2 mm. from the first incisors; the second incisors lie posterior to the first incisors, the roots being directed towards the mid-line; the crowns of the permanent canines slope slightly towards the mid-line, the left tooth lying in front of the root of the second incisor and the right tooth lying in contact with the distal aspect of the incisor.

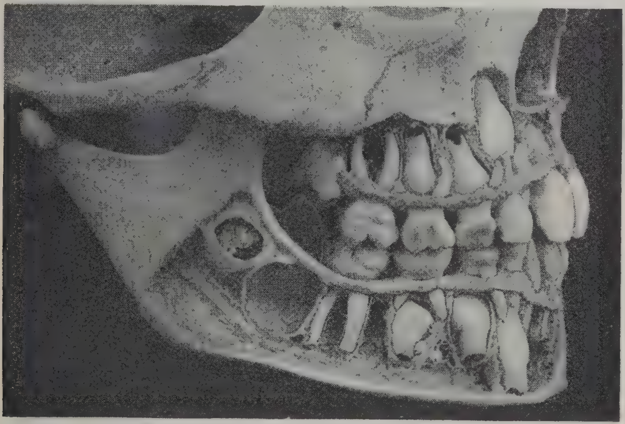


FIG. 301.—View of the right side of the specimen shown in fig. 298.

In the mandible, the incisors are crowded; each second incisor is rotated, with the mesial half of the crown posterior to the first incisor; the left permanent canine is almost vertical, while the right tooth has the crown directed away from the median line instead of towards it.

The irregularity of the teeth in this specimen would appear to be due to a lack of growth of the premaxilla leading to a narrowing of the anterior part of the arch and crowding. The crowding in the mandible is probably secondary to the small maxilla, the latter impeding the outward movement of the mandibular teeth.

Fig. 302 shows an example of general crowding of the anterior teeth. The arch of the maxillary teeth is distinctly narrow and the incisor teeth are crowded, the left canine being slightly

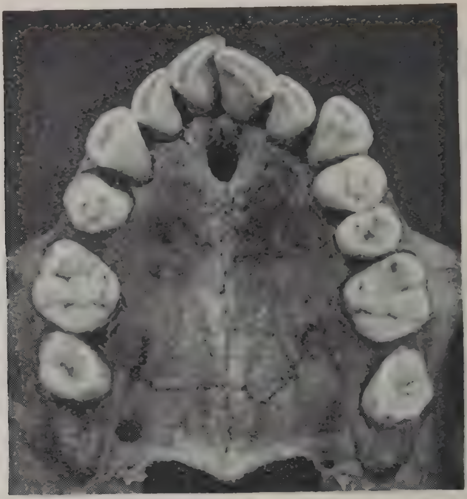


FIG. 302.

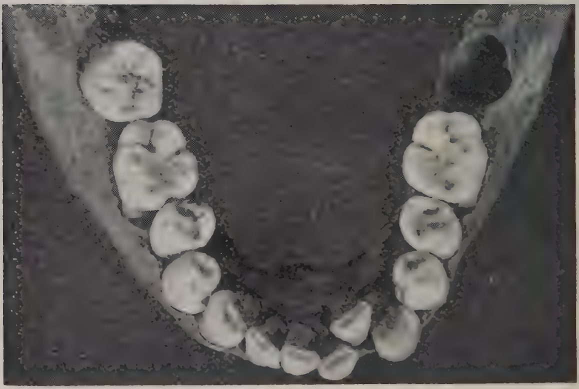


FIG. 303.

extruded. The right second premolar and the third molars are missing.

In the mandible, fig. 303, the narrowing of the arch has led to the forcing inwards of the left second incisor and slight crowding of the remaining incisors and right first premolar. The third molars are missing.

The occlusion of the teeth is shown in figs. 304 and 305.

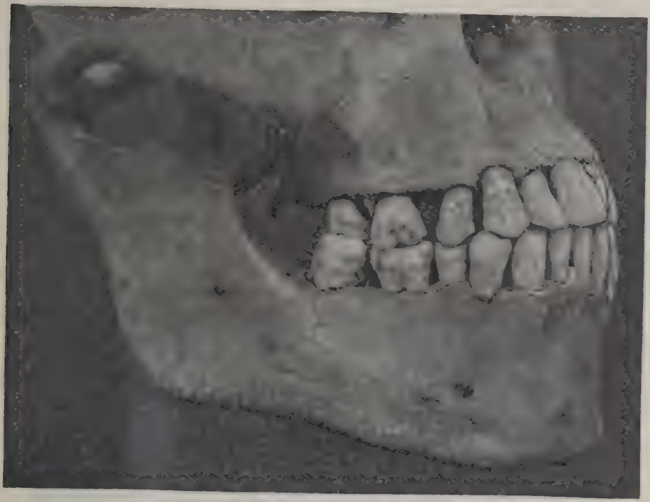


FIG. 304.—View showing the occlusion of the right premolars and molars of the specimen shown in figs. 302 and 303.

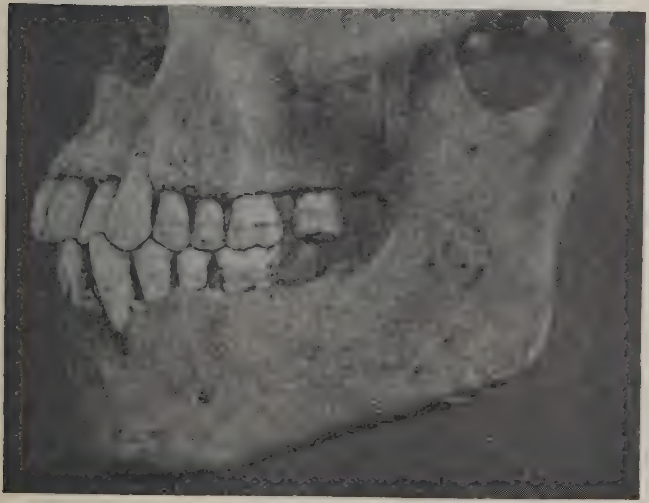


FIG. 305.—View showing the occlusion of the left premolars and molars of the specimen shown in figs. 302 and 303.

On the left side, fig. 305:—

(*a*) The outer cusps of the maxillary premolars and molars are but slightly external to the outer cusps of the mandibular teeth.

(*b*) The crown of the mandibular canine slopes towards the middle line and the cutting edge overlaps the distal angle of the maxillary second incisor.

(*c*) The crown of the maxillary canine is directed towards the middle line.

(*d*) The mandibular first incisor strikes against the distal angle of the maxillary first incisor.

On the right side, fig. 304 :—

(*a*) The maxillary first premolar and first molar are "flush" with the mandibular teeth.

(*b*) The maxillary second molar occludes internal to the mandibular teeth.

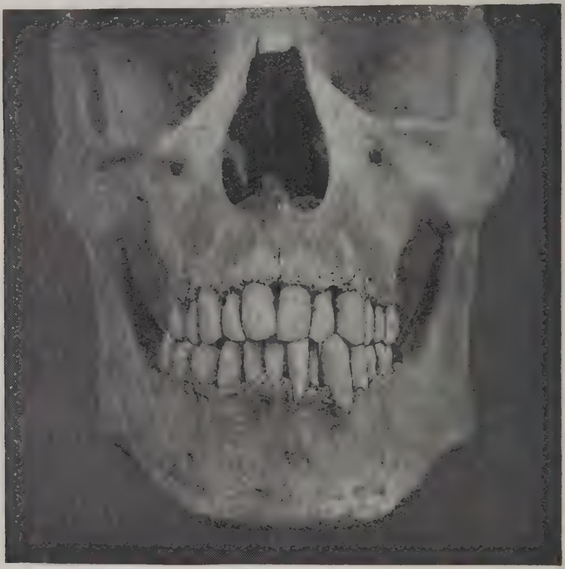


FIG. 306.—Anterior view of the specimen shown in figs. 302 and 303.

(*c*) The crown of the maxillary canine inclines forwards, the distal part of the occlusal margin meeting the anterior part of the mandibular tooth edge to edge.

(*d*) The crowns of the maxillary incisors slope forwards, the first incisor overlapping the tooth on the opposite side.

Viewed from the anterior aspect (fig. 306) the face displays a general narrowing, the malar process showing a downward curve at its junction with the malar bone. The alveolar process around the anterior teeth reveals definite signs of rarefying osteitis and there is a spur on the septum nasi. These circumstances suggest that the individual was an habitual mouth-breather, and that the contraction of the arch is the direct result of the muscular tension which is present in this condition.

(B) TREATMENT

(1) General Considerations.—In considering remedial measures for the treatment of crowding of the teeth, there are important points which should guide us in our choice of method.

Firstly, the prevalence of *caries of the teeth* should be borne in mind, and any method which would assist the lodgment of food and increase the difficulty of keeping the mouth clean should, if possible, be avoided.

Secondarily, the increasing liability to lose the teeth from *chronic periodontitis* is a reason for avoiding mechanical methods which are likely to damage the gingival margin.

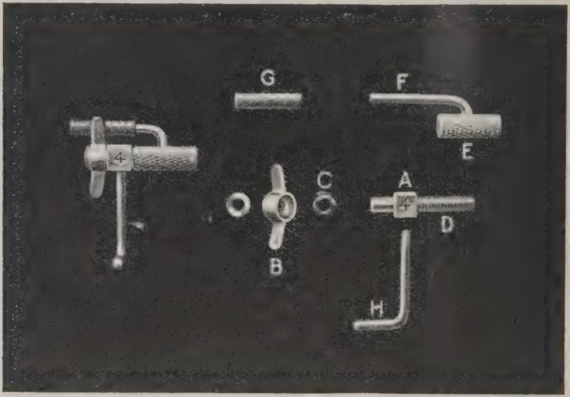
The main point constantly to be borne in mind is that the **crowding of the teeth is the direct result of interference with the growth of the bone,** or, in other words, where the bone is defective in growth the " arch " becomes too small to contain the normal number of teeth. From these premises it follows that, if a regular arch is to be secured, either the jaws must be stimulated to grow or the teeth must be reduced in number.

The teeth can be reduced in number by extraction; but can the jaws be stimulated to grow? Let us consider this question. It has already been shown that the jaws grow in a backward direction, that the only change in the bone after it is formed is a slight addition from the periosteum, and that growth is interfered with by lack of proper stimulation. If stimulation is restored, growth continues normally, but this growth does not occur in the region where the bone is deficient, namely, that part anterior to the molar. Indeed, it is difficult to see how any increase in this part can occur without interstitial growth, and there is no evidence to show that such growth occurs.

Some maintain that the jaw can be stimulated to grow and they adopt the method of treatment known as " expansion of the arch." This operation consists in moving all the teeth, or some of them, in an outward direction. On a previous page the movement of teeth under mechanical traction was discussed, and it was shown that, with the majority of appliances, the tooth, for all practical purposes, may be considered to swing on its apex. With " expansion of the arch " the crowns are made to occupy a greater arch and thus obtain relief, but the relief does not extend to the apical portions of the teeth, and as the crowded condition is only partially remedied there is a natural tendency for the crowns to relapse to their irregular positions.

It is claimed that if the crowns are kept in normal apposition, the expanding of the crowns will be followed by the expanding of the roots, and further that the movement of the teeth and alveoli stimulates the growth of the defective jaw, and, indeed, of all the bones of the face, and with them the nasal and accessory cavities. It is extremely difficult to understand how this can occur, and the evidence so far advanced by its advocates is far from convincing, especially as it is quite feasible that the improvement claimed to have been made was the result of natural causes.

It is urged against "expansion of the arch" that considerable derangement of the occlusion may result, but those who advocate



Left: Badcock's Screw, actual size. *Right:* Component Parts.

Fig. 307.—(a) is a square boss in the middle of the screw whereby the screw is turned. One end of this screw is smooth and revolves stiffly in the winged hub (b) in which is located the spring tension device (c); the wings are provided for the purpose of keeping the hub firmly fixed in the vulcanite. The other end of the screw (d) is threaded to correspond with the thread in the tube (e) which is knurled so that the vulcanite will hold it securely; soldered to (e) is a plain wire (f), the free end of which slides in the sleeve (g), which is closed at one end to prevent the entrance of the vulcanite, and is also knurled to give it a strong anchorage. This wire and sleeve give added rigidity to the apparatus, and, moreover, as the two halves of the plate must of necessity open parallel, it is impossible for them to revolve on one another. Fixed to one side of the square boss is a wire tag (h), which is embedded in the plaster when flasking to retain the device in position during the packing process; it is screwed out after vulcanization.

The plain wire (f) and the sleeve (g) can be shortened if necessary, as in the case of a very narrow palate.[1]

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[1] For the use of this block I am indebted to Messrs. C. Ash and Sons.

this method maintain that if derangement occurs it is due to faulty manipulation.

Expansion of the arch may be carried out with either removable or fixed apparatus. The most satisfactory removable appliance is that suggested by J. H. Badcock, which consists of a split vulcanite plate actuated by an expansion screw. The screw device (fig. 307) consists of a stout wire, one end of which is threaded and works in a tube, while the other is smooth and turns stiffly in a bearing. Between the threaded and smooth portions is a square boss, and fixed to the outside of the threaded tube is a parallel guide bar. The screwed tube is attached to one half of the plate and the screw in its stiff bearing is attached to the other half of the plate, the parallel guide serving to prevent rotation of one half of the plate upon the other. The boss is turned by means of a spanner a quarter turn every other day, or, roughly, one revolution per week, a rate which gives satisfactory progress without the slightest discomfort to the patient. In this way it is possible to calculate the time necessary for a given amount of expansion. The plate is best retained by Jackson cribs, for preference on deciduous molars, the plate being cut to a knife edge on the lingual side. An arrow should be engraved on the plate to indicate the direction in which the screw is to be turned. A typical case, showing the application of the Badcock screw, is shown in fig. 308.

In cases where the front teeth project a most useful adjunct to the expansion plate is a flattened flexible wire arch soldered to the crib on each side. The separation of the halves of the plate draws the wire tight and exerts backward pressure on the anterior teeth. The wire should be furnished with a U-shaped bend in the vertical plane in the premolar region of each side to allow of adjustment.

The shortening of any of the incisors can be effected by means of flat wires soldered at right angles to the arch and hooked over the cutting edges. It is generally desirable to employ two such hooks in order to prevent the arch from slipping up when tightened.

In Badcock's opinion the three operations of expansion, retraction and shortening can be effected with a plate such as that described above, and, as the plate can be easily manipulated by the patient when once it has been accurately adjusted, it is specially useful for cases which are withdrawn from skilled supervision for several months at a time, e.g., children at boarding school.

Of fixed apparatus for expansion of the arch E. H. Angle has introduced an appliance known as the "ribbon" expansion arch (fig. 310). It consists of a delicate flat wire (fig. 309), the ends being threaded and provided with friction lock nuts. The teeth

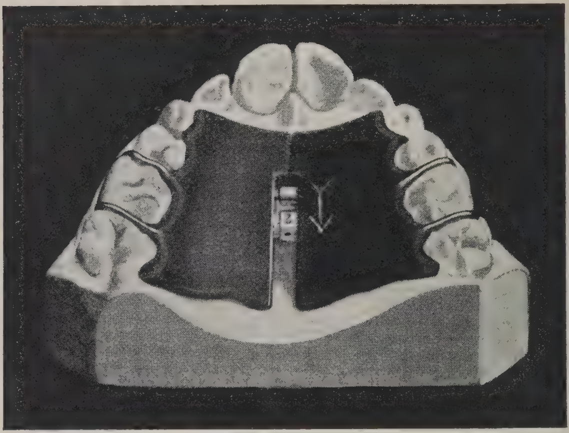

FIG. 308.[1]

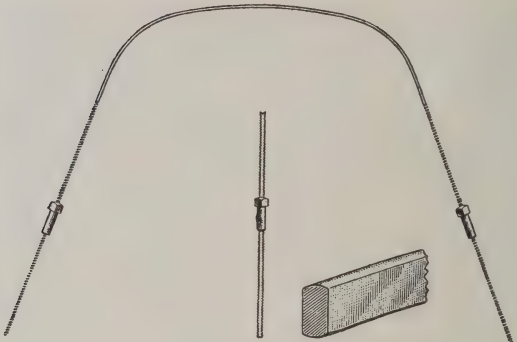

FIG. 309.[2]

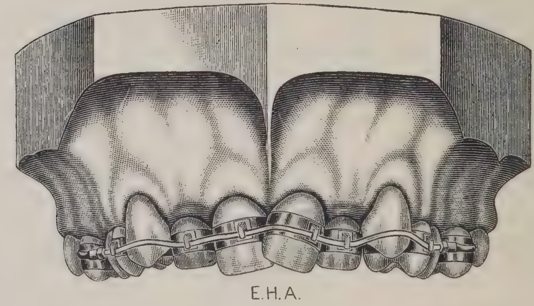

FIG. 310.[2]

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[1] For the use of this block I am indebted to Messrs. C. Ash and Sons.

[2] From *Dental Cosmos*, September, 1916.

used for anchorage are banded and bands are cemented to the various teeth to be moved, to the outside of each band a catch is soldered of the shape shown in fig. 310. The ribbon arch is fixed in position as follows: "One of its screw ends is inserted in the sheath of the anchor band of one of the first molars, and the friction lock nut is seated. The arch is then sprung with the fingers into the slots in the brackets, which it accurately fits, beginning with the one nearest to the first anchor band and proceeding in regular order until the anchor band on the opposite molar is reached, when the second nut is adjusted to approximately its proper position on the arch, but neither the end of the arch nor the friction portion of the nut are at this time placed within the sheath of the anchor band. The arch is then disengaged from all the brackets, but not from the sheath of the first anchor band. Now the screw of the loose end of the arch is slipped into its sheath on the second molar band, and the nut seated. Then, beginning as before, the arch is replaced in the brackets in exactly its former relation, the last step being the proper seating and accurate adjustment of the second nut in its anchor sheath."

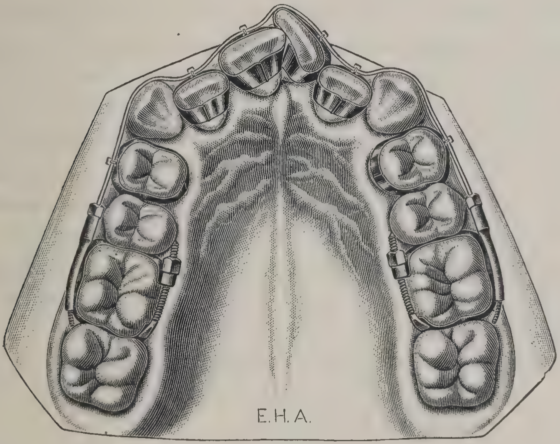

FIG. 311.[1]

"By studying the engraving, fig. 311, it will be easy to understand the manner in which the force is applied to each of the malposed teeth in order to effect not only their individual but also their collective movements. The elasticity of the arch, in this special case, operates constantly for the labial movement of the laterals, the torsional movement of the centrals, the buccal movement of the first premolars, and the lingual movement of the canines. And, as there is no waste of power through the slipping of attachments, the movement of the teeth must continue until the force from the elasticity of the arch as then bent has become exhausted, and the arch passive. Force is renewed by removing the arch and bending it to more nearly ideal form, when it is again sprung into place in the brackets and sheaths. By this means the teeth are moved continuously, until finally the ribbon arch has been given the exact form desired for the dental arch, and the teeth, through their bracket attachments, have been made to conform perfectly to it. As the metal of which the arch is made is very elastic, and as the ribbon form permits much greater range of elasticity than does a round arch, the force will be continued for a corresponding longer period before it is necessary to remove the arch and modify its form. Indeed, but two or three modifications during the whole course of treatment would probably be enough in most cases. The force is gently and almost continuously operative in exactly the right direction, without the injurious disturbance of cell function which must follow the use of any mechanism that requires frequent removal and replacement." (Angle.)

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[1] From *Dental Cosmos.*

The majority of those who favour expansion recommend that treatment should commence soon after the eruption of the incisors, the deciduous second molars being used as anchorage.

It will readily be seen that expansion entails a long period of mechanical treatment, and this is most undesirable from the point of view of the hygiene of the mouth.

Advocates of expansion claim that the facial expression is improved by the attainment of ideal occlusion, but this is after all largely a matter of personal opinion. The features in many of the illustrations of cases of expansion seem to the writer to have lost rather than to have gained in expression.

In considering the alternative treatment of crowded arches, namely, extraction, the following points can be urged in its favour:—

(*a*) Room is gained for the roots of the teeth as well as for the crowns.

(*b*) Mechanical treatment is minimized and in many cases dispensed with.

(*c*) Isolation of the teeth is often obtained, and this is a point of therapeutic importance in the prevention of caries.

(*d*) The occlusion is but little deranged, provided that the extraction is judiciously carried out.

(*e*) The teeth invariably assume better directions.

In the large majority of cases extraction is far preferable to and would appear to be more rational than expansion of the arch.

When employing extraction, it is rarely needful to remove a **first incisor.** Occasionally, the removal of the **second incisors** or **canines** is necessary. Generally, a tooth posterior to the canine can be removed and a choice has to be made between the first and second premolars and the first permanent molar.

The removal of the **first premolar** has the advantage of relieving the crowding of the anterior teeth more easily than the removal of either the second premolar or first permanent molar. Its removal causes little disturbance of the occlusion of the teeth. If, however, the amount of room required is slight, there is some risk of creating too great a space between the canine and the second premolar.

Extraction of the **second premolar** provides less room than removal of the first premolar, but more room than removal of the first permanent molar. The occlusion of the teeth is only slightly disturbed, and any space that may result would be between the first premolar and first permanent molar and would be less unsightly than a space between the canine and second premolar. Removal of the second premolar has the advantage of freeing the anterior surface of the molar, and this will lessen the tendency to caries and allow any caries which may exist to be more easily treated.

Removal of the **first permanent molar** gives less room than the removal of the first premolar, or, probably, the second premolar. The treatment necessary is also more prolonged and the occlusion of the teeth is liable to be disorganized, the mandibular second molars tilting, and the premolars, both maxillary and mandibular, rotating. As an organ of mastication the first permanent molar is most important. It possesses the largest area of crown surface and is situated in that part of the arch where the muscles of mastication work to greatest advantage. Its importance as an organ of mastication is so great, and the disturbance to the articulation caused by its removal often so marked, that it should be removed for the relief of crowding only in cases when it is unsavable. Under all other circumstances the choice should lie between the first and second premolars; if both teeth are free from caries, the first should be removed if the crowding is marked; if little space is required the choice should fall on the second premolar.

A combination of extraction with expansion is occasionally useful in cases where the amount of crowding cannot be wholly overcome by expansion, and yet expansion is to some extent desirable.

The Effect of Expansion of the Arch on the Nasal Fossa.—Children suffering from nasal obstruction associated with a contracted arch are often referred by the rhinologist to the dental practitioner with the view of expanding the arch to relieve the nasal stenosis. In justification of this operation it is claimed that the median maxillary suture may be forced open by rapid expansion, the separation of the bones will then allow the septum to straighten itself and bone growth will take place at the median line, the result being that the floor of the nasal fossa is permanently widened. The claim is supported by appearances seen in radiograms before and after treatment. But such evidence is extremely unsatisfactory. The distortion of radiograms of the maxilla is well known, and there is special difficulty in taking two pictures at the same angle which is necessary for such evidence.

In considering whether the nasal fossa may be affected by expansion of the arch, the anatomical relation of the parts must be first considered. The maxillæ have as lateral abutments the malar processes, the malar bones and the zygomatic arches with their attachments to the sides of the brain case, and these abutments are still further supported by the pterygoid processes and the vertical plates of the palate bones. They are permanent structures of comparatively hard bone, whereas the bone of the alveolar process is of far softer character. If the maxillæ are forced apart, the lateral abutments must give way, and it is not reasonable to think that they would yield before the softer bone of the alveolar process. It is, however, a clinical fact that in a few cases of marked constriction of the posterior part of the arch nasal respiration is improved by spreading the arch. M. Cryer[1] has suggested a reasonable explanation of this phenomenon. The effect of the narrow arch is to compress the tongue and force it back into the oro-pharynx. "The tongue," he says, "pushes up the soft palate against the pharyngeal wall and cuts off respiration through the nose. As the tongue forces the epiglottis downwards and backwards it also interferes with oral respiration, which, however, is a little easier than nasal respiration, under those circumstances, hence 'mouth-breathing.'" Spreading the dental arch gives relief to the nasal obstruction by allowing more room for the tongue which moves forward and releases the pressure on the soft palate and other structures.

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[1] *Items of Interest,* January, 1913.

(2) Treatment of Cases coming under Observation before the Premolars and Canines have Erupted.—Where crowding is inevitable, treatment should be commenced at an early age. For simplicity of description this question will be considered under two headings: (*a*) Cases where the first permanent molars are unsavable. (*β*) Cases where the first permanent molars are savable.

(*a*) *Where the First Permanent Molars are Unsavable.*

In these cases good results accrue from a line of treatment somewhat similar to the following: The first permanent molars are filled or treated in the manner best calculated to retain them until the second permanent molars have erupted. The crowding of the maxillary and mandibular incisors is then relieved by the removal of the four deciduous canines. If the teeth erupt in the normal way, the first and second premolars will come into good position. and we shall then have the following condition: the four incisors and the four premolars will be in a regular arch with a greater or less space between the second incisors and the first premolars so that the canines erupt just external to the arch; in other words, we shall have to deal with a fairly simple irregularity, namely, the canines high in the arch. To make room for the canines, the first permanent molars should be removed directly the second permanent molars are fairly through the gums. A plate to hold back the second molars should then be inserted. This plate (fig. 312) is

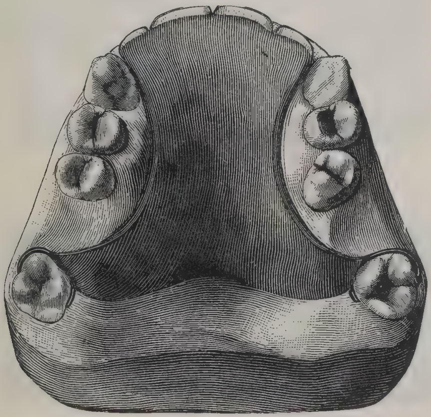


FIG. 312.

made to cover the palate so that it comes in contact with the palatal surfaces of the incisor teeth, while to the back of it are fixed half-round gold wires which pass around the anterior and buccal surfaces of the second molars, the plate being quite free of the premolars. This form of plate retains the second molars in position and prevents them from moving forward, while at the same time it allows the premolars to fall back, partly by the action of the bite and partly by the pressure of the canine tooth, so that many cases require no further mechanical treatment—a point of no small importance. Obviously, this line of treatment will not be suitable in all cases. In some patients, the mandibular front teeth are so crowded at an early age that extraction of at least one of them becomes necessary. A good example of this is seen in fig. 313. Here the first permanent molars are quite unsavable, and the crowding of the mandibular incisors is excessive. This condition is due to pressure from the canines, and removal of the first permanent molars will not sufficiently relieve the pressure to allow the second incisors to assume anything approaching a normal direction. If left untreated, the mandibular canines will, in all probability, erupt in a plane anterior to the second incisors. Removal of the right first incisor, however, will relieve the crowding and allow the remaining teeth to assume good directions. The result of treatment is seen in fig. 314 (see also p. 250).

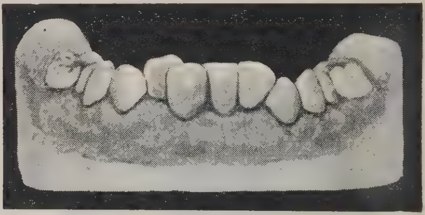


FIG. 313.

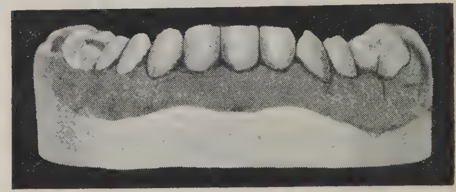


FIG. 314.

Another example, which could hardly be treated on the general principles just indicated, is to be found in cases where at an early age it is clear that the maxillary permanent canine will erupt over the position of the second incisor. In these circumstances, the second incisor is forced much internal to the bite, or is so twisted that it occupies a very abnormal position. The second incisors must be extracted, and this should be done before the canines erupt. The first permanent molars should be removed before the eruption of the second permanent molars, in order that the latter may move well forward and so fill up the gap caused by the extraction of the first permanent molars. This will prevent undue spacing between the anterior teeth, which would be unsightly.

When the pulp cavities of the first permanent molars are exposed, these teeth, if retained until the desired time, are liable to become an active source of sepsis. In such cases the best line of treatment is to remove the first permanent molars and the deciduous molars; the removal of the latter teeth allows the developing premolars to travel backwards and relieves the crowding of the anterior teeth.

(β) *Where the First Permanent Molars are Savable.*

Attention should, in the first instance, be directed to the first permanent molars, and the filling of these teeth should be performed in the most permanent manner possible. The probable position of the permanent canine should next be determined. If the incisors are in a fairly regular line, or if the second incisor has its mesial angle tilted forward, it may be assumed that the canine will erupt posterior to the incisor. If, on the other hand, the distal edge of the second incisor is projected forward, and the apex of that tooth is directed towards the median line, it may be assumed that the canine will, in all probability, erupt over the situation of the incisor, and the same may be assumed if the incisor is placed much internal to the bite, and the deciduous canine lies close to the first incisor.

Where the canine shows signs of erupting posterior to the second incisor, the treatment must depend upon the degree of crowding. If the crowding is slight, the deciduous canine should be removed and further treatment delayed until the permanent canines show signs of erupting. Either the first or the second premolar should then be removed, the choice depending upon the amount of space required for the erupting canines. In the case shown in figs. 315 to 318 the first premolars were removed immediately the canines showed signs of erupting.

If, however, the crowding of the incisors is marked, the unerupted first premolar should be removed. This operation permits the permanent canine to move backwards and so relieves the pressure on the anterior teeth (see fig. 319). It may be argued that extraction of the deciduous canine would suffice to remedy the position of the second incisor, but, if the dried specimen be carefully studied, it will be noticed that the removal of the deciduous canine will not provide room for the permanent canine.

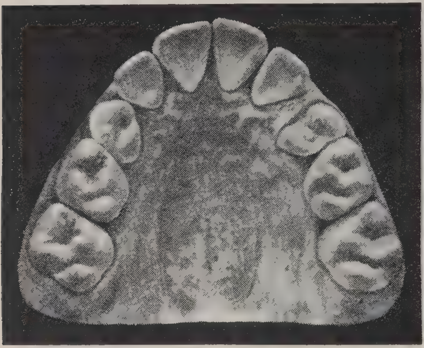


Fig. 315.—Upper, before treatment.

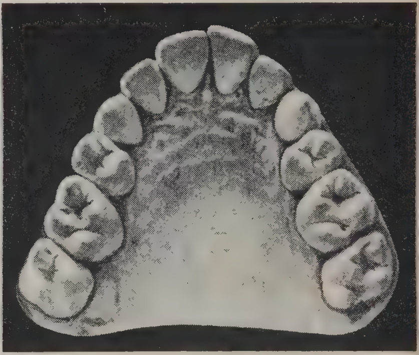


Fig. 316.—Upper, after treatment.

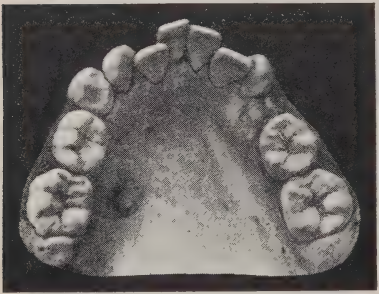


Fig. 317.—Lower, before treatment.

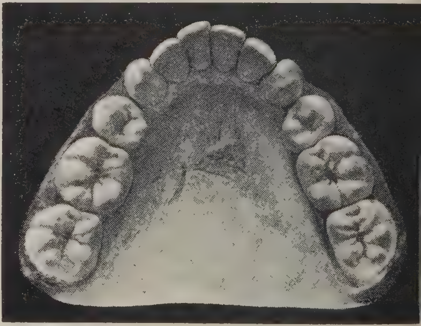


Fig. 318.—Lower, after treatment.

In performing this operation, an anæsthetic should always be given, as the removal of the premolar is frequently difficult. Nitrous oxide is quite sufficient if the operation is confined to one side of the mouth; but a longer period of anæsthesia must be obtained if it is necessary to remove both premolars at one sitting The most suitable instrument for the removal of the teeth is a pair of upper root forceps with rather long blades. The deciduous molar is first removed. In attempting the removal of the premolar, the inner blade of the forceps must be kept well inwards, the blades being thrust well upwards and extractive force applied in an inward direction. The occluding surface of the erupting premolar is directed slightly inwards, and, unless the precaution suggested is taken, the inner blade of the forceps impinges on the occluding surface and does not grip the inner aspect. The after-treatment of the wound consists in the use of an antiseptic mouth-wash.

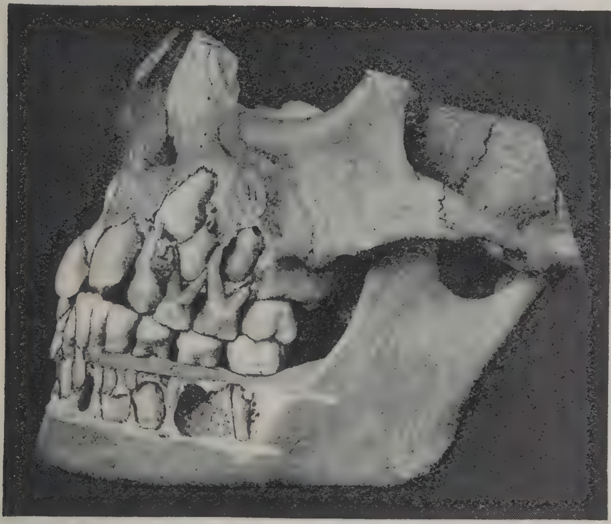


Fig. 319.—In this specimen the second incisor is placed internal to the arch with the canine partially covering the labial surface.

Treatment of crowded mouths in this manner gives excellent results. The canine moves into the space previously occupied by the premolar. Pressure on the front teeth is relieved, a good arch is obtained, and, what is most important, the teeth will be in excellent direction. In addition, mechanical treatment is avoided, and the occlusion of the molars and premolars remains good. Figs. 320 to 322 illustrate this method of treatment. At times, the space in the arch between the second incisor and the first permanent molar is insufficient even for two teeth, a condition shown in fig. 323. In these circumstances, the molar should be retracted until there is room for the canine and one premolar. The molar should then be retained in its new position and the first premolar extracted.

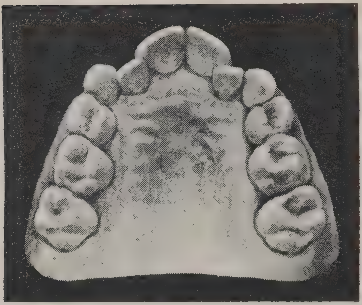


FIG. 320.—Before treatment. (In this case the second incisors had to be pushed forward over the mandibular teeth.)

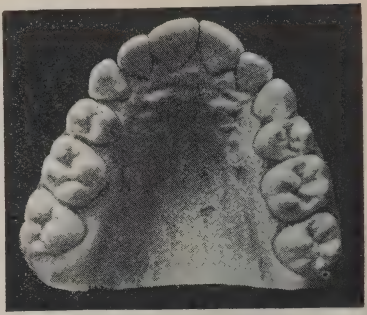


FIG. 321.—After treatment.

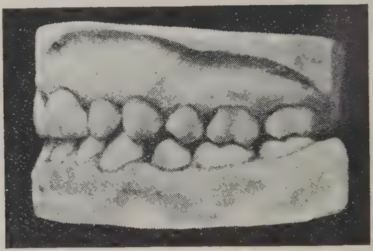
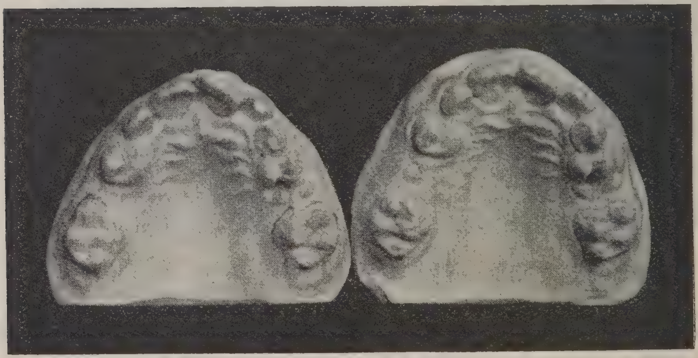


FIG. 322.—Side view, showing occlusion of premolars and molars after treatment.



(*a*) (*b*)

FIG. 323.—(*a*) before retraction of the first molar; (*b*) after retraction of the first molar.

The advantages of the early extraction of the premolars, where serious crowding is inevitable, are:—

(1) Pressure on the front teeth is relieved and any irregularity of position which they may have assumed is easily rectified.

(2) The canines and premolars come down in a good direction and form a regular arch.

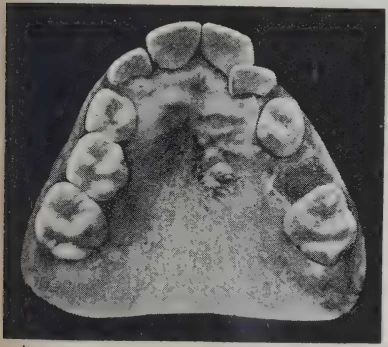


FIG. 324.—Before treatment.

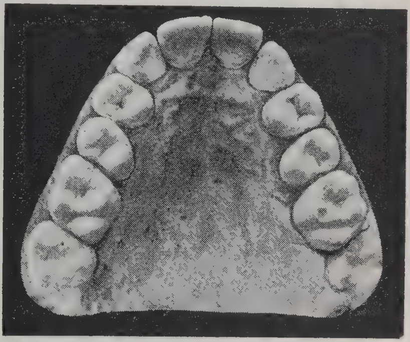


FIG. 325.—Case shown in fig. 324. After treatment.

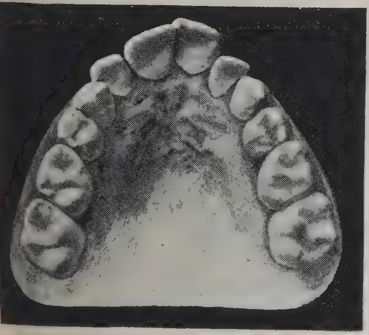


FIG. 326.—Before treatment.

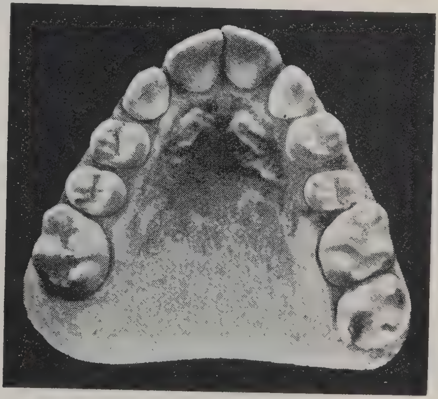


FIG. 327.—Case shown in fig. 326. After treatment.

Where the canines show signs of erupting over the situation of the second incisor, little advantage is gained by the removal of the premolars, and the more satisfactory treatment in such cases is to remove the second incisors before the canines erupt. Cases treated in this way are shown in figs. 324 to 327.

Where only a slight degree of crowding may be anticipated, early extraction of the first premolars leads to considerable contraction of the arch in the region of the canine, and it is better in such cases to delay treatment until the canines and premolars are in position and then to remove the second premolars.

(3) Treatment of Cases coming under Observation after the Premolars and Canines have Erupted:—

(*a*) **Crowding complicated by Disease of a First Incisor.**—The treatment of such cases must depend upon—

(i) The prospect of permanently retaining the affected tooth.

(ii) The degree of crowding.

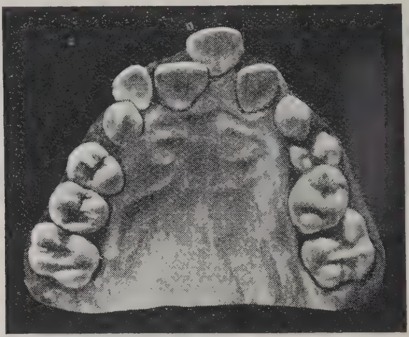


FIG. 328.

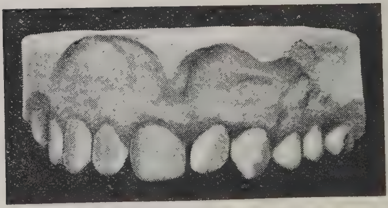


FIG. 329.—The case shown in fig. 328. After treatment.

(iii) The sex of the patient.

(iv) The age of the patient.

If the pulp of the first incisor died after the root was complete there is a reasonable prospect of saving the root and crowning it, provided that no serious periodontal trouble supervenes. Under these conditions, the tooth should be saved and the crowding treated by the removal of a posterior tooth. But if the pulp died before the completion of the root the tooth should be removed.

The question whether the space left by the removal of the tooth should be allowed to close up must be decided according to the merits of each case. With a boy, especially if there is considerable crowding as shown in fig. 328, the space should be allowed to close up in order to avoid the necessity for an artificial denture—a point of importance as far as the hygiene of the mouth is concerned. The unsightliness can usually be hidden to a great extent by a moustache in later life. With a girl, the disfigurement is of more serious import, and the space should therefore be retained by suitable means, an artificial denture being subsequently inserted.

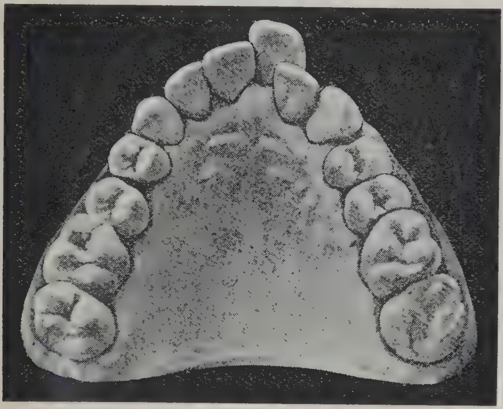


FIG. 330.

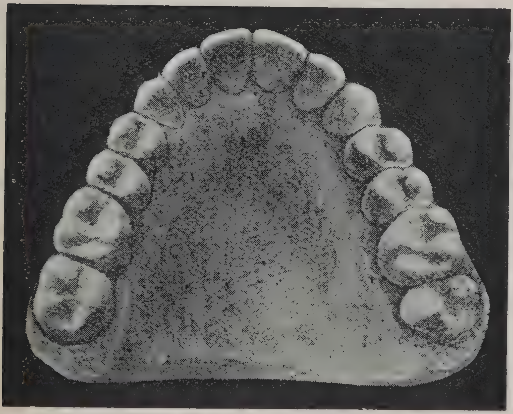


FIG. 331.

(β) **Crowding which has resulted in the Protrusion of a First Incisor.**—An example of this irregularity is shown in fig. 330. The patient was aged 21. The arch was expanded and the projecting incisor retracted. The result of the treatment is shown in fig. 331.

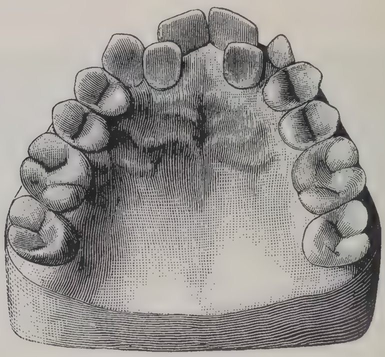


FIG. 332.

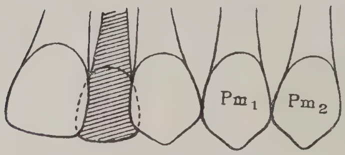


FIG. 334.—Case before treatment, showing positions of incisors and canine.

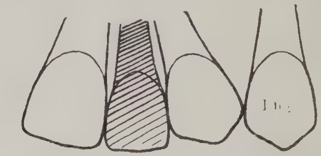


FIG. 335.—Result of treatment after removing the first premolar.

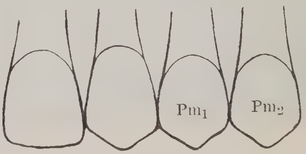


FIG. 336.—Result of treatment after removing the second incisor.

(γ) **Crowding which has resulted in the Exclusion of Second Incisors from the Arch.**—The advisability of sacrificing a second incisor in the treatment of crowding is constantly disputed, some practitioners even going so far as to maintain that under no circumstances can the adoption of such a course be defended. The principal argument urged against the removal of this tooth is that the canine erupts next to the first incisor and produces an unsightly appearance. It is true that a second incisor in correct position has a better appearance than a canine next to the first incisor, but where the extraction of a second incisor is in question, the problem to be solved may be set out as follows: Is it better to have a canine in correct alignment next to the first incisor and the premolar in apposition to the canine, or a second incisor in a maldirection, with, possibly, its cutting edge tilted forward and the canine sloping towards the median line, and, in all probability, short? For example, consider the case shown in fig. 332. The second incisors are displaced inwards to a considerable extent and are in a vertical direction, the canines being but slightly external to the arch. An examination of the roots of the teeth shows the canines to be sloping towards the median line, while the roots of the first premolars take the same direction. Extraction of the second incisors will effect a remedy without mechanical treatment; the canines will come down in good direction, the first incisors will fall back and assume a more correct position, while the premolars will move forward also into a vertical position. If an attempt were made to treat the case by extraction of the first premolars, the result obtained would, in all probability, be far from satisfactory. Even with a fairly good result, and with the teeth brought approximately into a normal curve, the difference in the slope of the teeth would produce anything but a pleasant appearance. The first incisors would be forced more outward, the second incisors would have the cutting edges directed forward, that is to say, the necks of the teeth would be in a plane well posterior to the first incisors, the cutting edges of the canines would be above the level of the second incisors, and the slope would be considerable. Further, this operation would entail prolonged mechanical treatment with all its attendant troubles.

A row of teeth in correct alignment with the canines next to the first incisors is more sightly than the canines and the incisors in bad alignment (see diagrams in figs. 334 to 336); moreover, it must not be forgotten that the public do not view the teeth with the critical eye of the practitioner.

A case calling for the removal of the second incisors is shown in fig. 337.

The cases which test the judgment most are those where the root of the canine is directed only slightly towards the median line and there is a possibility that the tooth may come into good direction if the premolar is removed. Under these conditions, the removal of the premolar would be the wiser course, especially if the patient is a girl.

Sometimes the second incisors are misplaced to such an extent that their extraction is imperatively called for and the first permanent molars are also quite unsavable. Under such conditions, the molars must be removed, if possible before the second permanent molars erupt, the latter will then come forward and, in a great measure, prevent a backward movement of the premolars, which would probably leave unsightly spaces between the front teeth.

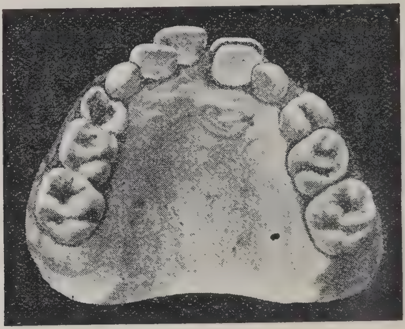


Fig. 337.

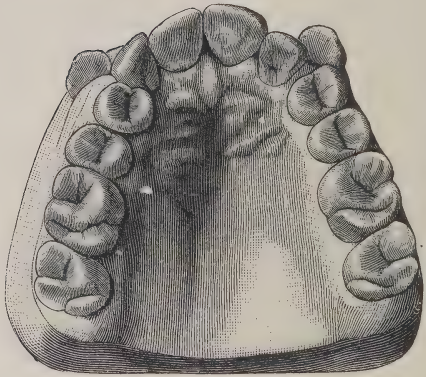


Fig. 338.

(δ) **Crowding which results in the displacement of the Canine either External or Internal to the Arch.** The displacement of a canine external to the arch is the commonest result of a crowded condition of the teeth. A typical example is shown in fig. 338.

In dealing with this irregularity, the importance of the canine in the dental arch should be borne in mind. It is the longest and probably the strongest and most highly developed tooth in the arch in which it forms a kind of keystone. It assists to give character to the face; and its extraction leaves a depression near the ala of the nose and in a measure robs the face of expression. For these reasons it should be retained whenever practicable. The choice of treatment usually lies between the removal of the canine, or, alternatively, the removal of the second incisor, a premolar, or the molar. The removal of the canine should be regarded as the last resource.

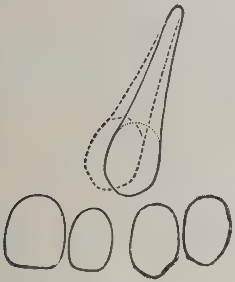


Fig. 339.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the second incisor is extracted.

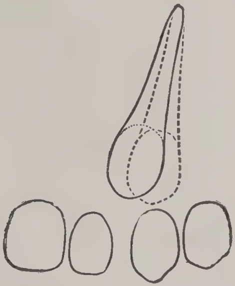


Fig. 340.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the premolar is extracted.

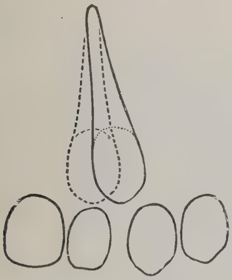


Fig. 341.—Showing the root of the canine lying over the second incisor. The dotted lines represent the direction the canine will take if the incisor is extracted.

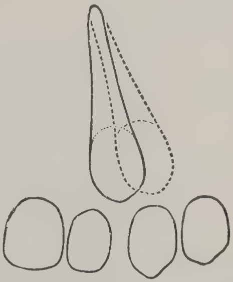


Fig. 342.—Showing the root of the canine lying over the second incisor. The dotted lines represent the direction the canine will take if the premolar is extracted.

Before selecting the tooth for removal the position of the root of the canine should be ascertained. If the root has a direction forward, the removal of a posterior tooth will cause the canine, when it erupts, to slope backwards to such an extent as to present an unsightly appearance, whereas if the second incisor is extracted the canine will erupt fairly straight. If the root of the canine is directed backwards a premolar or molar should be removed. The figures 339 to 342 illustrate these points.

Irregularities of the canines seldom require mechanical treatment, especially if extractions have been made with due regard to the bite. Nature will frequently overcome the difficulties unaided, and it is usually advisable to postpone further treatment for a period of from three to six months after extraction, but if the tooth does not then appear to be moving into position, it should be mechanically assisted, and one of the simplest methods in vogue is that shown in fig. 236.

In removing a premolar for the relief of a crowded canine attention must be given to the position of the corresponding mandibular premolar, for the latter may be placed in such a position as to prevent the maxillary canine from coming correctly into line. In certain cases, however, extraction of the canines is quite justifiable, especially where, with the arch regular and the occlusion good, the second incisors are fairly close to the premolars and the canines erupt outwards almost at right angles, as seen in fig. 343.

(ϵ) **Crowding which results in Displacement of Premolars.**—Displacement of the second premolar internal to the bite frequently results from crowding. When this occurs, the second premolar has usually erupted after the canine. Fig. 344 is an excellent example of this type of irregularity. The treatment would be the removal of the abnormally placed premolars, but if the molars were unsavable, it would be necessary to remove them and bring the premolars into the line of the arch.

(θ) **Crowding which results in the Displacement of a Mandibular Incisor.**—An irregular arrangement of the mandibular incisors caused by crowding is not uncommon, the canines being mainly responsible for the irregularity. The canines are normally developed external to the incisors, the crowns often slightly overlapping the labial surfaces of the second incisors, and where there is insufficient room for their development, the canines encroach on the incisor region and so cause irregularity.

Crowding of the anterior mandibular teeth is not so important from an æsthetic point of view as crowding of the anterior maxillary teeth. The most effective treatment when the crowding is severe is to remove an incisor. In selecting the incisor to be removed, the following points should be considered :—

(i) A first incisor should, if possible, be extracted in preference to a second incisor for reasons of symmetry. If a second incisor be removed, the canine on one side will be adjacent to a first, and on the other side to a second incisor.

(ii) An outstanding tooth should be removed in preference to one instanding, as the latter will be more easily brought into correct line, the pressure of the tongue being more powerful than that of the lower lip.

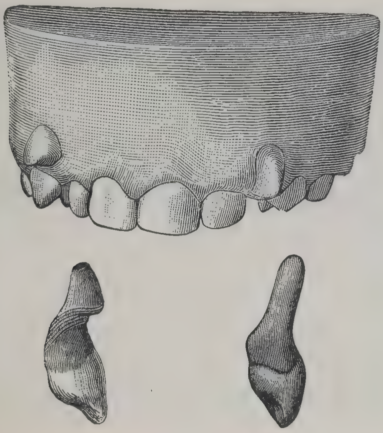


Fig. 343.

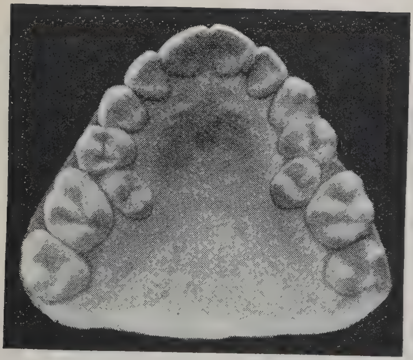


Fig. 344.

(iii) The direction of the roots of the different teeth is important. The tooth selected should permit of the remaining incisors assuming a vertical direction. For instance, in the case shown in figs. 345 and 346, removal of the right first incisor would allow the remaining teeth to assume vertical directions, but removal of the left first incisor would result in the right first incisor assuming a distinct slope.

(ι) **Mandibular Canines.**—Displacement external and internal to the arch may occur, the former being more common. The principles of treatment are similar to those for maxillary canines.

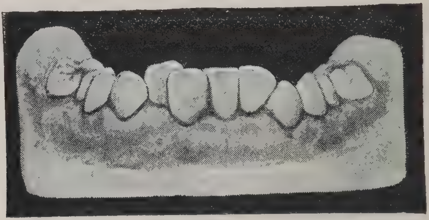


Fig. 345.

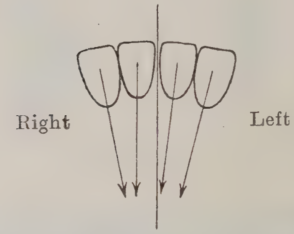


Fig. 346.—Diagram showing directions of the roots of the incisors.

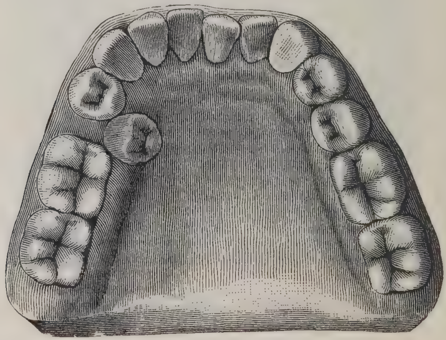


Fig. 347.

The removal of a mandibular canine does not mar the expression of the features to the same degree as the removal of the maxillary canine. The mandibular canine should be removed in cases where it is much external to the arch with the first premolar and the second incisor in good alignment.

(*κ*) **Mandibular premolars** placed external or internal to the arch (see fig. 347) require removal.

(λ) **Cases involving the Malposition of Several Teeth.**—The treatment of general irregularity of the teeth will depend, to a great extent, upon the general condition of the teeth. If the first molars are unsavable their removal is indicated, but opinions differ as to the proper time to remove them in order to obtain the best results. From examination of mouths in which there is an absence of crowding of the teeth but the first molars have been removed, it would appear that the best results are obtained when these teeth are removed before the eruption of the second permanent molars,

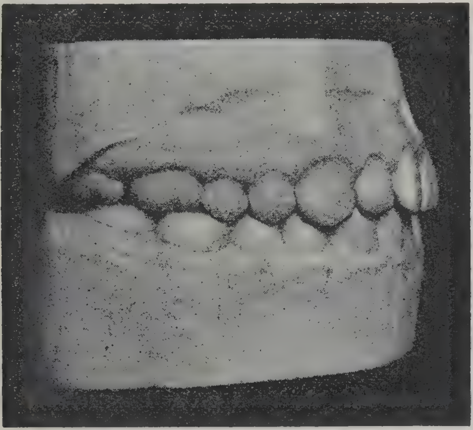


Fig. 348.—Models of a case in which the first permanent molars were removed for caries before the eruption of the second molars.

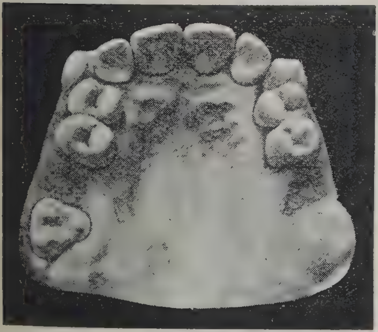


Fig. 349.—Before treatment.

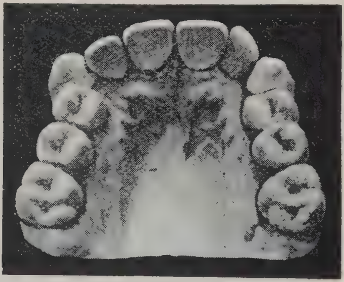


Fig. 350.—After treatment.

and after the eruption of the premolars, as good spacing between the anterior teeth is then obtained and there is far less tilting of the mandibular second molars (fig. 348). A strong objection to removing the first permanent molars at this period, in cases of crowding, is that the second permanent molars, especially the maxillary, move forward and encroach on the space required for the backward movement of the anterior teeth. In cases where the teeth are crowded the extractions should be delayed until the appearance of the second permanent molars. Many practitioners advise postponement of extraction until the second permanent molars are fully erupted and in good occlusion in order to minimize the tilting of the mandibular second molars, but if the operation is thus delayed the crowding will be less easily remedied, as the teeth will have become more firmly implanted and the irregularity of the anterior teeth more pronounced. On the whole therefore it seems advisable to remove the first permanent molars as soon as the second molars are sufficiently through to allow of the application of mechanical means for holding them back (see fig. 312). In this way the crowding can be relieved at an earlier period, and the tilting of the second molars is, to a great extent, prevented.

The ill-effects of removing the first molars, in cases of crowding, before the second molars erupt are seen in figs. 349 and 350.

A certain number of cases come under treatment in which the mandibular first molars have already been removed and no attention has been paid to the maxillary teeth. The following case is instructive[1]:—

Owing to the removal of the mandibular first molars a year previously, the second permanent molars have travelled forward and partly articulate with the maxillary first molars; the maxillary left second premolar is displaced inwards, but otherwise there is practically no crowding (see figs. 351 to 357). Some of the maxillary incisors have been attacked by caries on the approximal surfaces. The maxillary left first molar has a cavity on the masticating surface, while in the maxillary right first molar a cavity has been successfully treated on the anterior surface.

The occlusion of the teeth on the right and left sides is diagrammatically shown in figs. 352 and 353.

On the left side it will be noticed that the maxillary second premolar is internal to the arch. The articulation between the maxillary first premolar and the mandibular premolars is not good. The maxillary first molar is prevented from moving forward by the second premolar and is only half opposed, while its posterior cusps prevent the mandibular second molar from

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[1] The following cases are fully described with the view of showing the various points to be considered when adopting extraction for the relief of crowded conditions of the mouth.

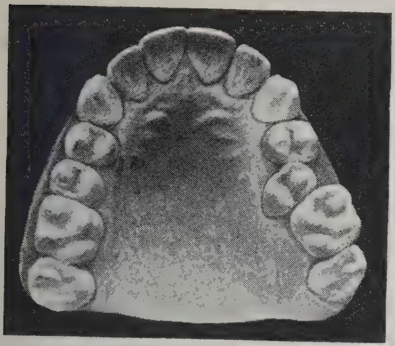

FIG. 351.

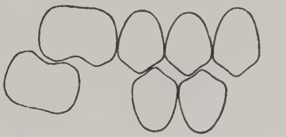

FIG. 352.—Right side.

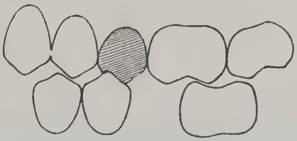

FIG. 353.—Left side.

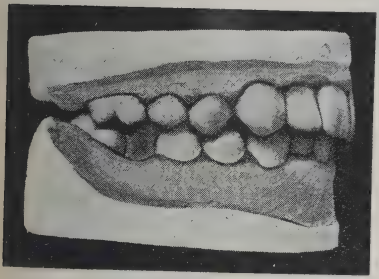

FIG. 354.
Before treatment. Right side.

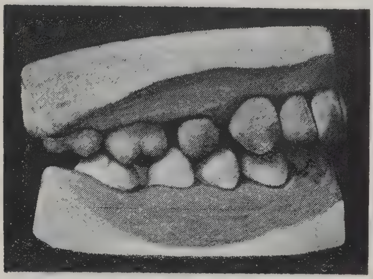

FIG. 355.
After treatment. Right side.

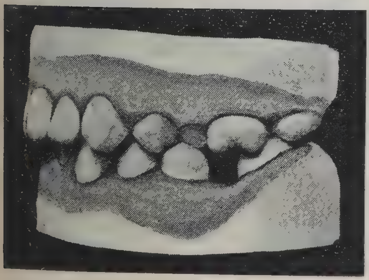

FIG. 356.
Before treatment. Left side.

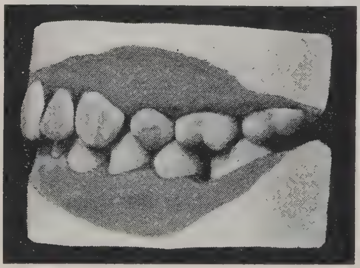

FIG. 357.
After treatment. Left side.

moving forward. The maxillary second molar is erupting, hence a posterior force is present. Extraction of the second premolar will allow the maxillary first molar and the mandibular second molar to move forward, and so lead to an improvement in the articulating surface. On the right side it will be seen that the anterior plane of the maxillary first premolar only partially articulates with the posterior plane of the corresponding mandibular tooth, and that there is no articulation with the anterior plane of the mandibular second premolar as there ought to be. Only half the anterior plane of the maxillary second premolar is used. The maxillary first molar is only partially in occlusion with the mandibular second molar and this prevents the latter moving forward. The maxillary second molar is erupting. Extraction of the maxillary second premolar would permit the maxillary first premolar to move backwards and articulate correctly with the mandibular premolars. The maxillary first molar and mandibular second molar would move forward and the articulation would be improved. The maxillary second premolars were removed and the result is seen in figs. 355 and 357.

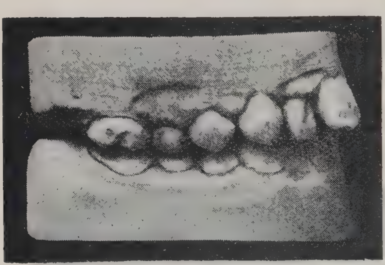

Fig. 358.
Before treatment. Right side.

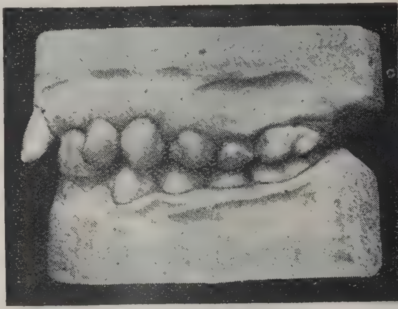

Fig. 359.
Before treatment. Left side.

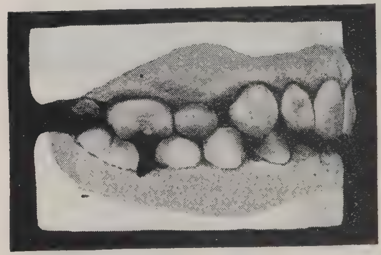

Fig. 360.
After treatment. Right side.

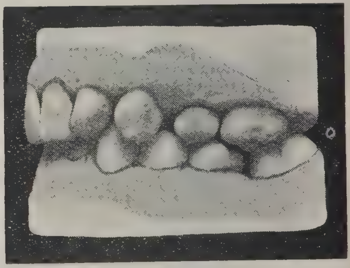

Fig. 361.
After treatment. Left side.

Where there is marked crowding in the maxilla, with the maxillary first molars savable and the mandibular first molars unsavable, the best results are to be obtained by removing the mandibular first molars before the eruption of the second molars. The latter will then come forward and articulate well with the maxillary teeth. The maxillary first premolars should be removed, if possible, before the canines erupt. In this way, the crowding of the maxillary teeth can be correctly overcome and a good articulation obtained. A case thus treated is shown in figs. 358 to 361.

Second premolars should, as a rule, be removed where the crowding is not great. Should a space remain, it will not be so noticeable as if the first premolar had been extracted. Removal of the second premolars is indicated where caries is present on the anterior approximal surfaces of the first molars.

The following is an instructive case requiring the removal of the maxillary second premolars:—

The patient was a girl aged 15. The maxillary front teeth were crowded and irregular (fig. 362). The mandibular teeth presented a good arch. An examination of the premolar and molar occlusion on the right side showed that only portions of the posterior planes of the first and second premolars were in contact with the mandibular teeth (fig. 364). This is diagrammatically shown in fig. 368. Removal of the maxillary first premolar would allow the second premolar to come forward and occlude with both mandibular premolars and at the same time allow room for the canine to move backwards, but the second premolar on this side was carious. With removal of the second premolar the first premolar could be brought back and made to articulate satisfactorily with the mandibular premolars, and the crowding of the front teeth would be overcome. On the left side (fig. 366) the mandibular second premolar had not erupted, and there were no signs of its presence. The maxillary second premolar, therefore, formed but a small portion of the masticating area and was consequently the tooth to remove.

The treatment consisted in the removal of the maxillary second premolars. The first premolars were then brought back by mechanical means. A vulcanite plate capping the molars and premolars was made, half-round gold wires being attached to the sides and arranged so as to bring pressure on the mesial angles of the right first and the left second incisors. Opposite the palatal aspect of the left first incisor, a wedge of compressed wood was inserted and the tooth brought forward. By a similar arrangement, the distal angle of the right tooth was driven forward. A retention plate was used for twelve months. The result is seen in figs. 363, 365, 367. A regular arch has been obtained. The occlusion of the teeth on the right side has been improved. On the left side, the occlusion has not been impaired and will be improved when the molars move forward.

In a few cases the removal of a second incisor on one side and a premolar on the other may be necessary. The following is an example:—

In this patient, a girl, the anterior maxillary teeth were crowded, the second incisor on the left side being internal to the arch (fig. 369). In the mandible, the arch was regular, but the first incisors were absent. The teeth were free from caries. An examination of the roots of the left first

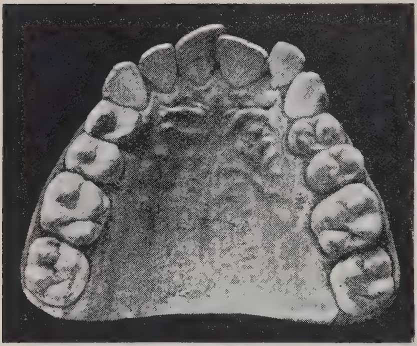

FIG. 362.—Before treatment.

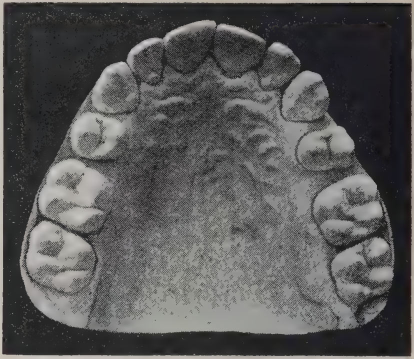

FIG. 363.—After treatment.

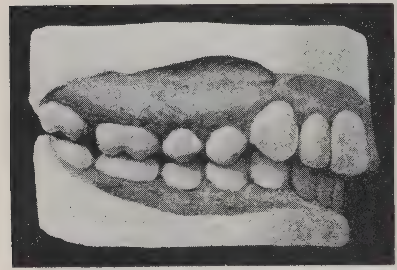

FIG. 364.—Right side. Before treatment.

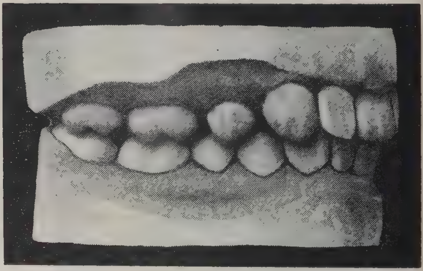

FIG. 365.—Right side. After treatment.

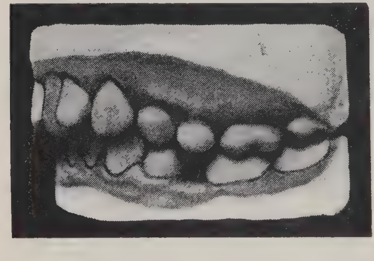

FIG. 366.—Left side. Before treatment.

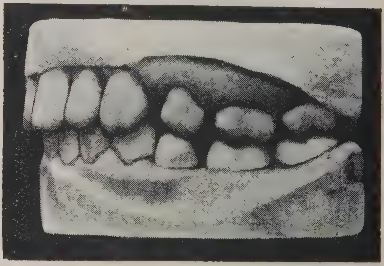

FIG. 367.—Left side. After treatment.

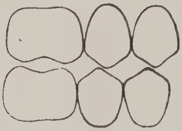

FIG. 368.

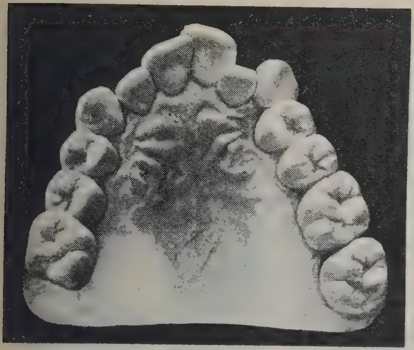

FIG. 369.—Before treatment.

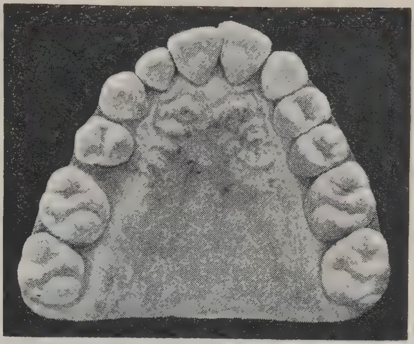

FIG. 370.—After treatment.

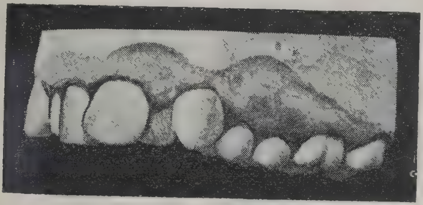

FIG. 371.

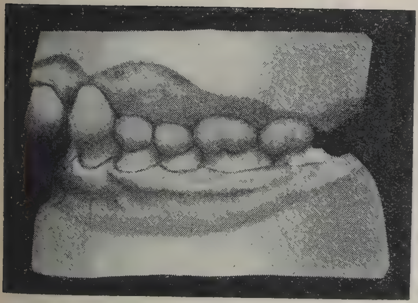

FIG. 372.—Left side. Before treatment.

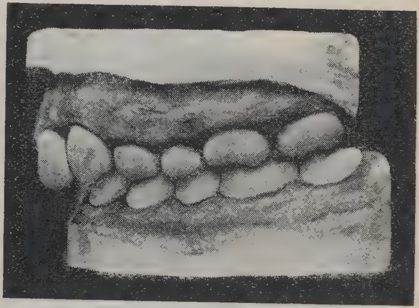

FIG. 373.—Left side. After treatment.

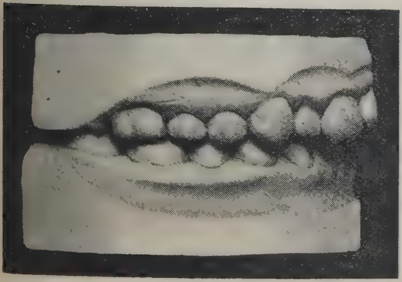

FIG. 374.—Right side. Before treatment.

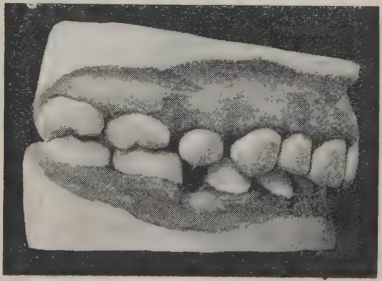

FIG. 375.—Right side. After treatment.

and second incisors and canine showed that the root of the first incisor sloped in a backward direction and was placed in a plane anterior to the root of the second incisor and also overlapped that of the right first incisor. The canine root was very slightly backward and was also in a plane anterior to the second incisor. The positions of the three teeth are shown in fig. 371. The occlusion of the premolars and molars was good (fig. 372). On the right side, the root of the canine was directed backwards, and the crowding of the incisors was slight. The relation of the maxillary to the mandibular premolars and molars is shown in fig. 374. In considering treatment, the main difficulty was the marked crowding on one side and the slight crowding on the other. On the left side, two courses were open: (*a*) the removal of the first premolar, or a posterior tooth; (*b*) the removal of the second incisor. If removal of the first premolar were carried out, the canine would need to be retracted and the second incisor pushed out. This operation would probably result in the canine assuming a very sloping direction and being short, the second incisor having its cutting edge tilted forward, while the first incisor would be driven still more across the median line. In addition, the treatment would require the prolonged

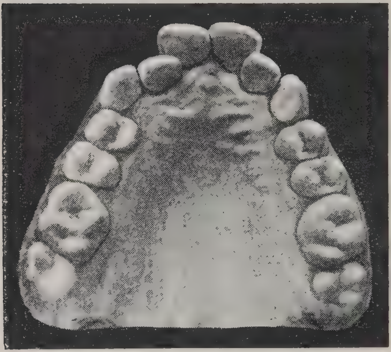
Fig. 376.—Before treatment.

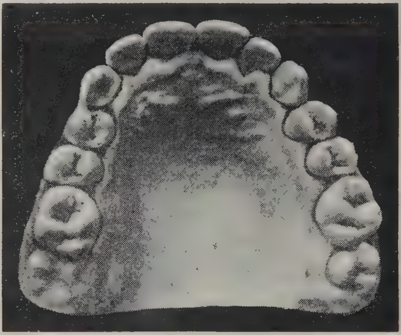
Fig. 377.—After treatment.

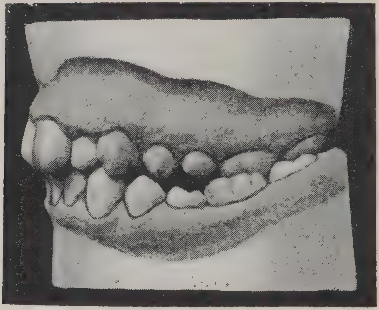
Fig. 378.—Before treatment.

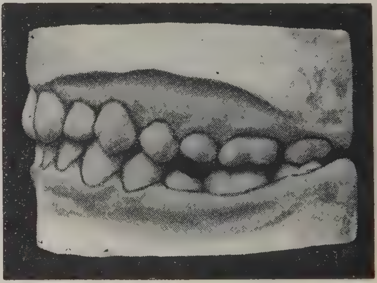
Fig. 379.—After treatment.

use of a plate, and there would be a constant tendency to relapse. On the other hand, removal of the second incisor would permit the first incisor to fall back and assume a more vertical direction and the canine would move forward and fill up the gap. There would be true relief of the crowding (both roots and crowns), and no tendency to relapse. On the right side, but little room is required, and removal of the second incisor to correspond with removal of the left tooth is out of the question. The treatment, therefore, resolves itself into the removal of a premolar or a molar. The molar is free from caries, so a choice must be made between the first and second premolars. Removal of the first premolar would, in all probability, result in a gap between the canine and the second premolar. Removal of the maxillary second premolar alone, and retraction of the first premolar

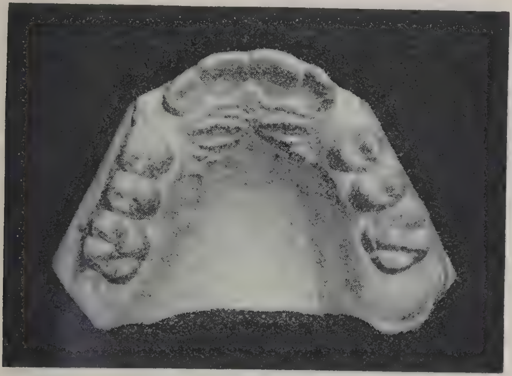

Fig. 380.—Before treatment.

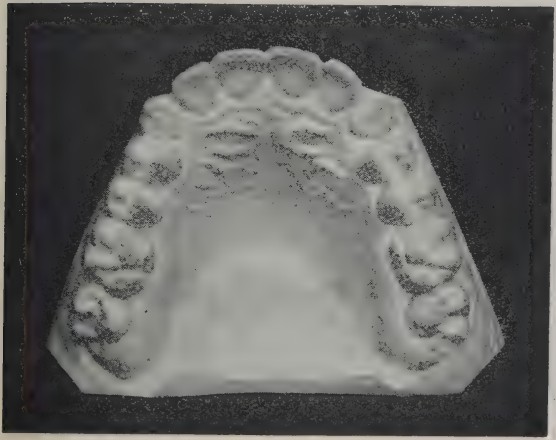

Fig. 381.—After treatment. The second permanent molars have erupted.

would also leave a gap, because the first premolar would eventually occupy the same position as the second premolar. Removal of the mandibular second premolar as well as the maxillary second premolar would allow the first premolars, maxillary and mandibular, to move back sufficiently to overcome the crowding of the incisors and canine, while the molars would move forward and assist in filling up the gaps. In addition, mechanical methods would be avoided. Treatment consisted in the removal of the maxillary left second incisor and the maxillary and mandibular right second premolars. The result of treatment is seen in figs. 370, 373 and 375. On the right side there is a slight gap between the premolar and canine, but when the case was last seen the molars had moved still more forward and had considerably improved the occlusion of the maxillary premolar with the mandibular premolar and first molar. With the advent of the third molars, the space will, no doubt, be entirely closed.

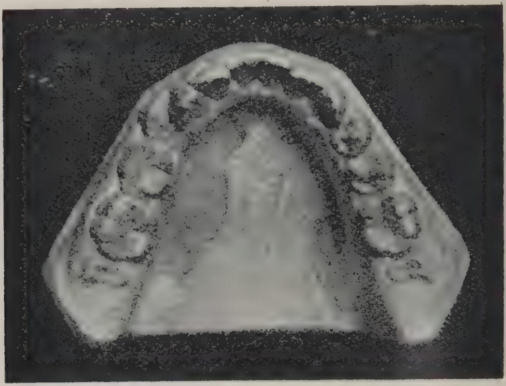

Fig. 382.—Before treatment. The second molars have partially erupted.

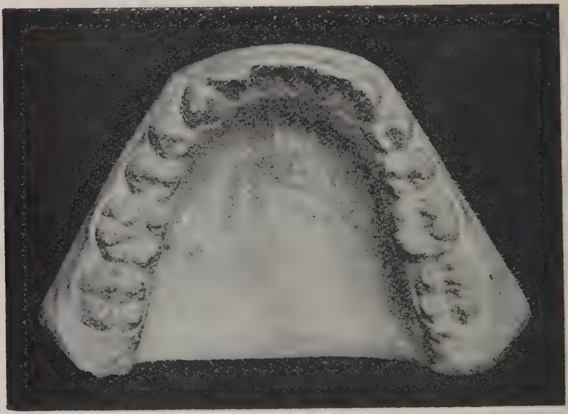

Fig. 383.—After treatment. The second molars have completely erupted.

The operation of expansion may be adopted in cases where the general lie of the premolars and molars is inwards, and where the articulation and the personal appearance of the patient will be improved by the operation. A case treated by expansion is shown in figs. 376 to 379.

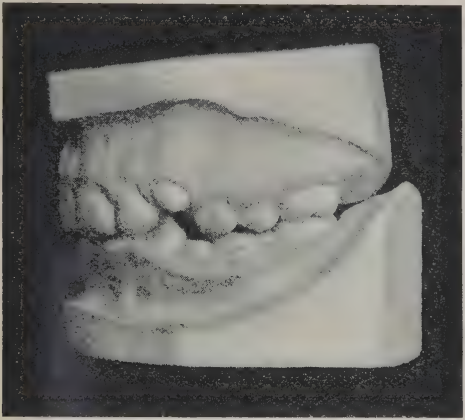

Fig. 384.—Left side before treatment.

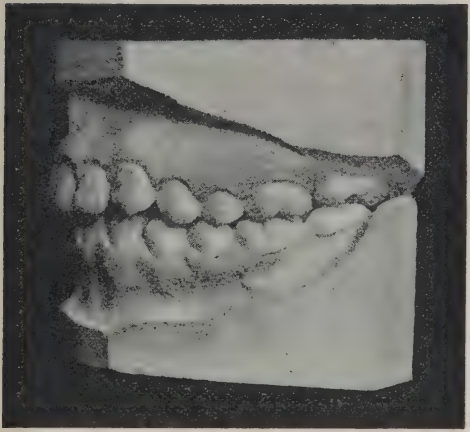

Fig. 385.—Left side after treatment.

Figs. 380 to 387 are the models of a case of crowding of the teeth under the care of G. Northcroft, which he treated by means of expansion. The child was breast-fed for three months and then hand-fed, a boat-shaped bottle being used. No adenoids. The first models of this patient were taken at the age of 8 years 4 months, and showed slight crowding of the maxillary and mandibular anterior teeth. As the condition did not improve and the occlusion was getting worse, it was decided at the age of 10 years

9 months to adopt operative treatment. From the models shown in figs. 384 and 386, it will be noticed that the molar occlusion is correct on the left-hand side, but on the right-hand side the maxillary molar is in advance of its normal position and presents a flush occlusion. The treatment consisted in applying expansion arches to the maxillary and mandibular teeth, combined with inter-maxillary reciprocal traction. Pressure was brought to bear on the maxillary first molars, and a band and spur applied to rotate the maxillary left second incisor. At the end of a little over four months, the appliances were removed and vulcanite retention plates inserted. The models, shown in figs. 381, 383, 385 and 387, represent the case a year and three months after completion of treatment.

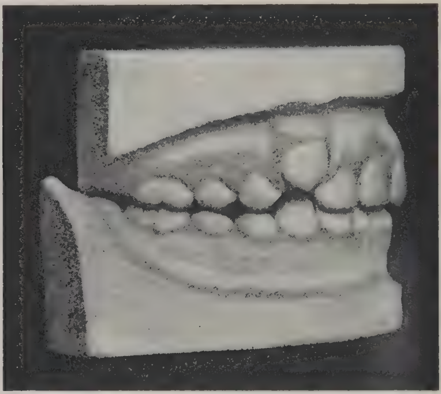

Fig. 386.—Right side before treatment.

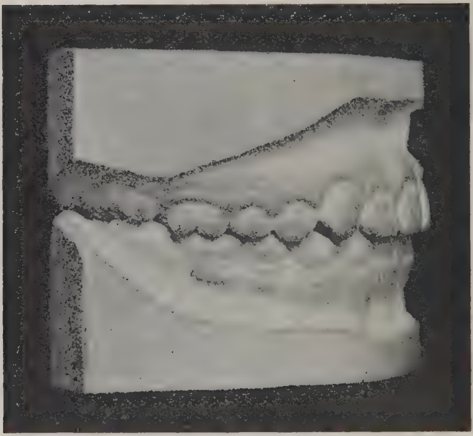

Fig. 387.—Right side after treatment.

The following are the comparative measurements of the case when seen at 10 years 9 months and when completed :—

	10 yrs. 9 mths.	Completion of treatment
Width between 3|3 at tips	35·5 mm.	37 mm
,, ,, 4|4 ,, gum-line	24·6 ,,	27 ,,
,, ,, 5|5 ,, ,,	30·5 ,,	33 ,,
,, ,, 6|6 ,, ,,	36 ,,	38 ,,
Depth of palate at 6|6 from gum-line	11 ,,	15 ,,
Length of jaw from palatal sulcus of molar to 1|1	35 ,,	36 ,,
The combined distances between 4|4 and 2|2 are	6·5 ,,	12 9

The average expansion being about 2 mm.

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CHAPTER IX

Abnormalities of the Teeth (*continued*)

Superior Protrusion—Inferior Protrusion—Open Bite—Abnormalities due to Congenital Defects of the Jaw

(A) SUPERIOR PROTRUSION

The term "superior protrusion" is applied to that type of irregularity in which the maxillary front teeth project abnormally. In most cases of superior protrusion the upper teeth project beyond the lower lip which passes behind them and, the upper lip failing to cover them, they remain partly or wholly exposed.

Protrusion of the maxillary incisors may occur either in the permanent or the deciduous dentition. In the deciduous dentition the maxillary incisors are placed almost in a vertical position and in close contact with the labial aspects of the mandibular incisors. A slight forward movement of the maxillary incisors sometimes occurs and may escape notice, but it is important because it foreshadows protrusion in the permanent series. In their crypts the permanent maxillary incisors have their cutting edges directed a little outwards, and a forward movement of the deciduous arch tends to increase the outward direction of the permanent incisors, with the result that in the process of erupting the teeth are liable to pass in front of the lower lip. Should this occur the irregularity is accentuated by the twofold action of the lower lip which tends to force the upper teeth forward, and the lower teeth backward.

(1) *Etiology and Pathology*

Cases of superior protrusion may be divided into groups, each of which possesses clearly defined characteristics.

Group 1.—The jaws are well developed; the maxillary incisors are spaced; the mandibular incisors may present a normal curve, in which case the cutting edges are free from the muco-periosteum of the palate; or the arch may be flattened, with the cutting edges touching the palate. The occlusion of the molars may be normal or slightly abnormal. The projection of the maxillary incisors is usually traceable to an upward and outward pressure on the palatal aspects of the teeth, such as would naturally result from the habit of sucking the lower lip or the prolonged use of a teething pad.

In figs. 388 to 390 are shown the models of a case of protruding maxillary incisors; the child was fed with a " boat-shaped bottle," had been free from " tonsils and adenoids," had not used a " comforter," but had sucked the lip vigorously and, even at the time when the models were taken, was addicted to that habit.

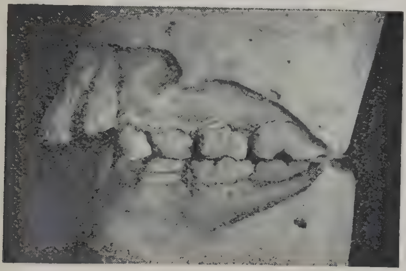

Fig. 388.—A case of superior protrusion due to sucking the lower lip.

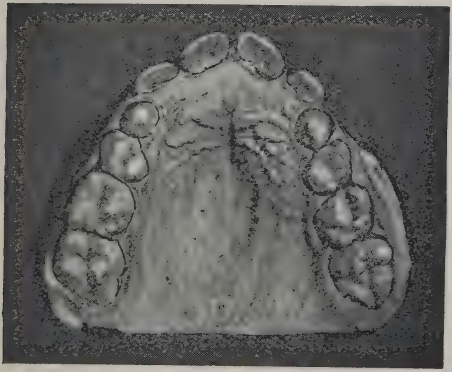

Fig. 389.—View of the maxillary teeth of the case shown in fig. 388.

There can be little doubt that vigorous sucking of the lip is a powerful factor in producing protrusion of the teeth. I have seen a child, three and a half years of age, addicted to this habit, whose mandibular incisors had been driven backwards over the tongue and were placed about three-quarters of an inch behind the maxillary teeth.

It is possible that in cases of lip sucking the backward pressure in the mandible may lead to changes in the neck of the condyle, a subject referred to on p. 150.

Group 2.—There are no indications of deficient growth of the jaws; the dental arches are contracted and the maxillary premolars and molars are usually in abnormal occlusion. The morbid anatomy of this type of superior protrusion is shown in fig. 391.

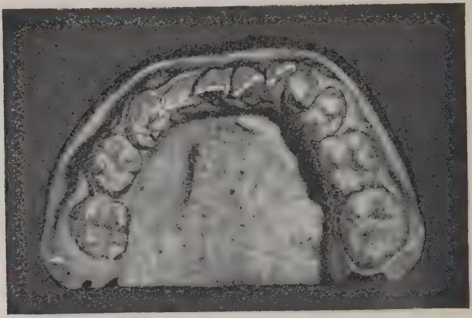

FIG. 390.—View of the mandibular teeth of the case shown in fig. 388.

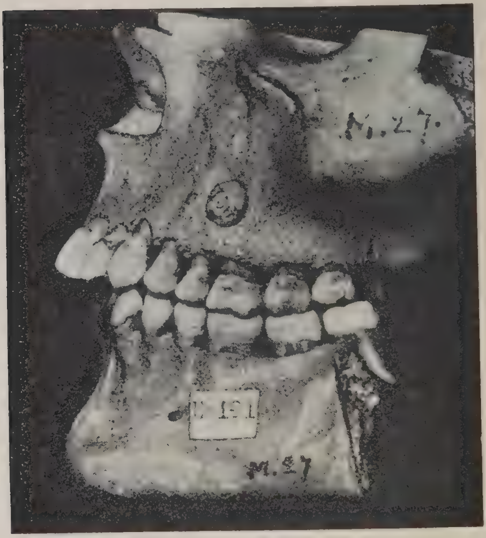

FIG. 391.

The maxilla and the mandible are well developed. In the maxilla the canines and incisors project; the premolars and molars have an abnormal forward slope and occlude anterior to their normal position. In the mandible the premolars and molars are in normal position, but the canines and incisors show the flattening which is characteristic of many cases of superior protrusion. The illustration in the profile shows that the chin is well formed and that the part of the bone which is at fault is the alveolar process. The protrusion was due to a forward movement of the maxillary teeth, which was sufficient to allow the lower lip to lie posterior to them, and exert a backward pressure on the mandibular incisors and canines.

In this type of superior protrusion the narrowing of the arch is more marked in the premolar than in the molar region.

Another important feature is the frequency with which an abnormal forward occlusion occurs in this type of superior protrusion. The abnormal forward occlusion implies either that the maxilla is normal and the mandible is imperfectly developed or that the whole of the maxillary teeth have moved forward. In the specimen, fig. 391, the body of the mandible is well developed and protrusion is due to a forward movement of the maxillary arch. This forward movement is attributable to the habit of thumb-sucking or to the prolonged use of a dummy teat "comforter"; the persistent sucking action brings pressure to bear on the sides of the arch and the anterior segment carrying the canines and incisors is forced forward. At the same time a backward pressure is exerted on the lower teeth, and, as a result, the arch is flattened, the incisors often assuming a fan-shaped arrangement and are in contact with the muco-periosteum of the palate.

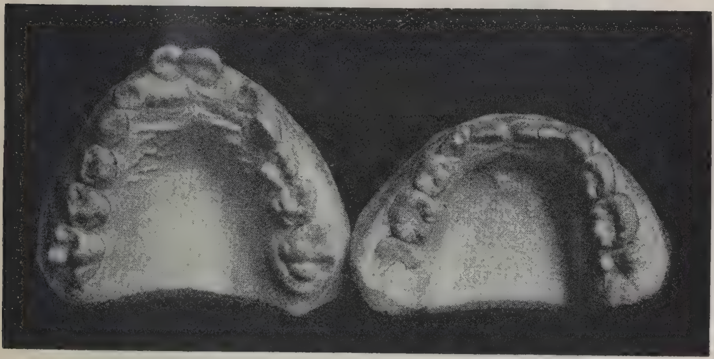

Fig. 392.—A case of superior protrusion due to persistent thumb-sucking. Breast-fed. No adenoids.

The models (figs. 392 to 394) are from cases due to persistent thumb-sucking.

Group 3.—There is deficient growth of the maxilla due to the presence of adenoids, the projecting incisors presenting a crowded arrangement. The specimen, fig. 395, is an example of this type of superior protrusion. The first molars are in normal occlusion;

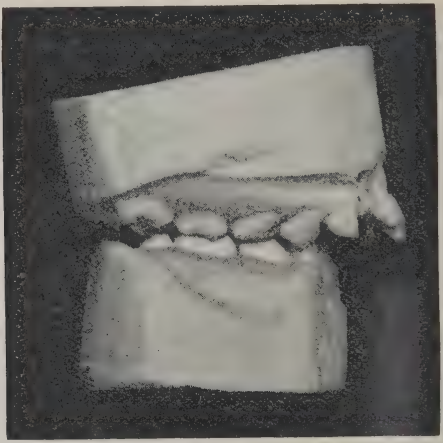

Fig. 393.—Side view of case shown in fig. 392.

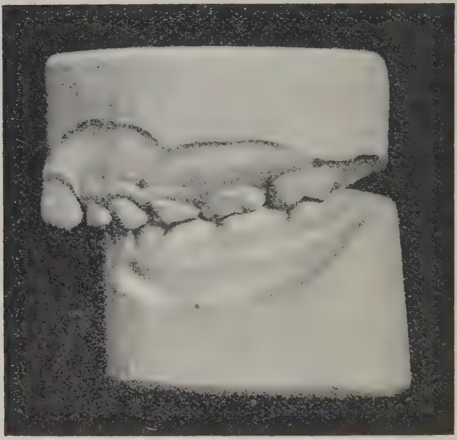

Fig. 394.—Breast-fed four months, then hand-fed with "boat-shaped" bottle. No adenoids. Thumb-sucker until 4 years of age. The arch of the incisors and canines is regular. The lower incisors do not impinge upon the upper gums.

the canines and premolars have an abnormal forward slope; the maxillary incisors are crowded together, the apical portions of the roots being directed towards the median line, with the roots of the second incisors partially covered by those of the first incisors. The

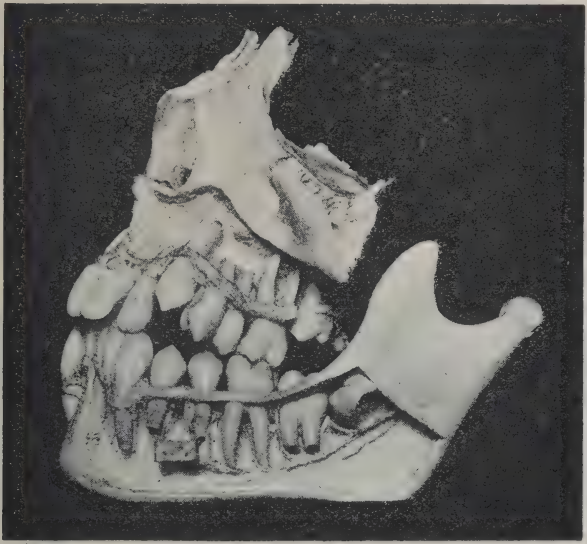

FIG. 395.

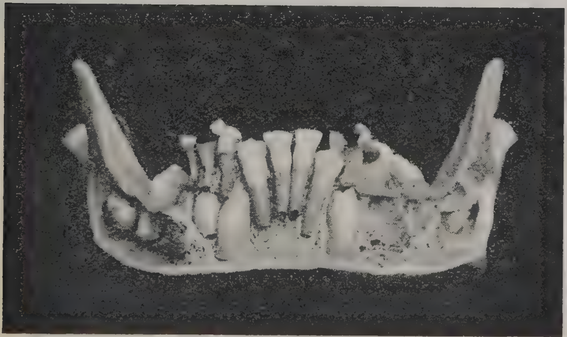

FIG. 396.

mandible is better developed than the maxilla. The incisors and canines are crowded, and present a fan-shaped arrangement which is due to the pressure on the incisors exerted by the growing canines. The incisors are wedge-shaped teeth, the thin ends of the wedges being at the apices. If four wedge-shaped pieces of wood are placed side by side pressure on the thin ends of the wedges will force the centre wedges upwards, and this is exactly what happens with the lower incisors when the growing canines exert pressure on the roots of the second incisors (fig. 396).

In discussing the effect on the jaws and teeth of the presence of adenoids it was shown that adenoids usually conduce to incomplete growth of the premaxilla, which results in a crowded arrangement of the incisors, also to a narrowing of the arch and, in marked cases, the anterior part of the arch may be pushed forward, causing superior protrusion. It is doubtful, however, whether the extreme protrusion seen in many of these cases is wholly to be attributed to the presence of adenoids and to the effects resulting therefrom. If a considerable number of children suffering from adenoids are examined it will be found that, while many of them have superior protrusion, a greater number will have a crowded condition of the teeth without superior protrusion. The frequency of abnormal occlusion in cases of superior protrusion would suggest that other causes are operating to produce this forward movement of the arch. In the majority of cases included in this group there is a history of the use of the "comforter" or of thumb-sucking, and these habits may be the determining factor in causing the protrusion. The models (figs. 397 and 398) are from a hand-fed child which suffered from adenoids until 8 years of age and had used a "comforter" for nine months.

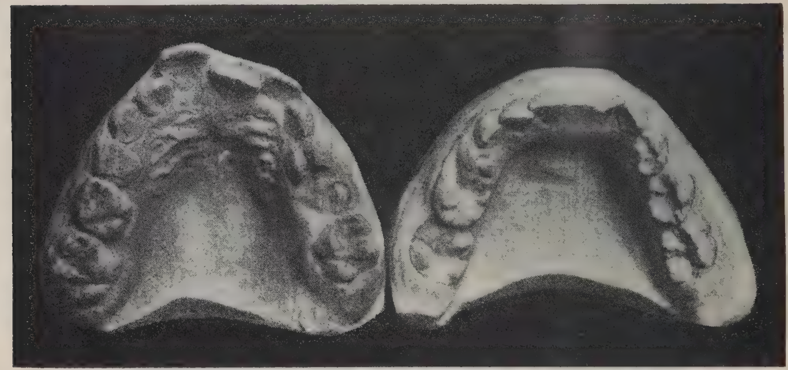

Fig. 397.—Hand-fed with a boat-bottle. Suffered from adenoids until 8 years of age. Comforter used for nine months. Occlusion 0·0. Upper incisors show a crowded condition. Lower incisors impinge on upper gums.

Group 4.—The skull shown in fig. 402 illustrates the morbid anatomy of this group of cases.

The distance between the cutting edges of the upper incisors and the labial surfaces of the lower teeth is 4 mm., the cutting edges of the lower teeth being quite free from the palatal aspects of the upper teeth. The occlusion of the first molars is normal.

The palatal aspect of the upper arch is shown in fig. 401, and it will be observed that (1) the incisors and canines slope unduly forwards; (2) the occluding surfaces of the first permanent molars face slightly backwards; (3) behind the erupting second molars there is no development of a tuberosity; (4) there is a distinct narrowing of the arch in all directions, more especially in the region between the canines and first premolars. The widths are as follows: between the (*a*) first permanent molars 34 mm.; (*b*) first premolars 25 mm.; (*c*) canines 20 mm.[1]

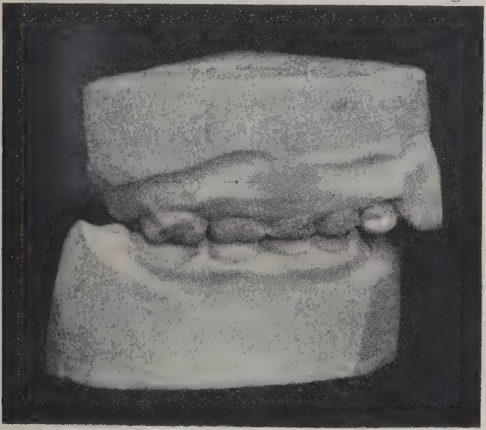

FIG. 398.—Side view of case shown in fig. 397.

The arch of the lower teeth is regular, and the anterior teeth are somewhat more vertical than in the normal. Side views of the skull are illustrated in figs. 399 and 400 and show the abnormal slant of the upper incisors. Examined more in detail, it will be noticed that the roots of the incisors converge towards the middle line. The occlusion of the first molars is normal and they are placed directly under the malar process. The outer alveolar process had been removed when the skull passed into the collection, and it is therefore impossible to define the extent of the sinus but it would appear from an examination of the specimen that the sinus was very small and did not extend quite to the region of the second premolars. The skull of this child (fig. 402) if compared with the skull of a child about the same age, fig. 403, shows a definite lack of growth of the frontal sinuses and the bones of the face. The comparative measurements of the skulls point to a lack of growth of the maxilla. The effect of this lack of growth would be to narrow the space available for the teeth and cause a crowding together of the roots and a forward movement of the crowns. In other words, if the roots of the teeth could be brought forward and

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[1] The measurements between the premolars and canines are approximate, as the teeth have not fully erupted.

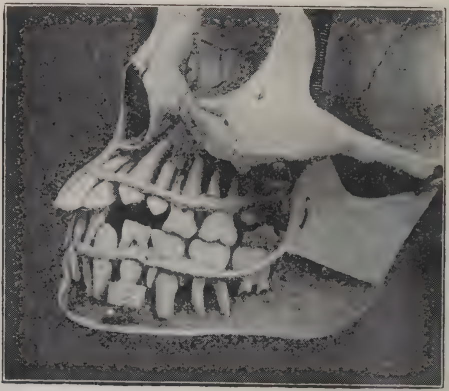


Fig. 399.

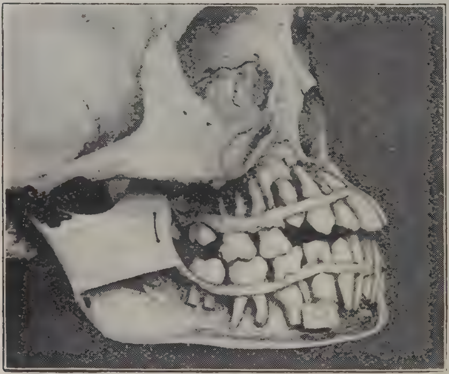


Fig. 400.

spaced by a growth of bone the crowns would occupy a broader circle and the teeth would be more upright.

Group 5.—The arches are well formed and of normal width with the exception of an undue forward slope and spacing of the upper and lower incisors; the premolars and molars are not erupted to their normal height; the mandibular incisors are above the level of the premolars and molars and impinge on the cingula of the upper teeth. The pathology of this condition is obscure. The condition seems to be due to diminished growth of the ramus. If the ramus

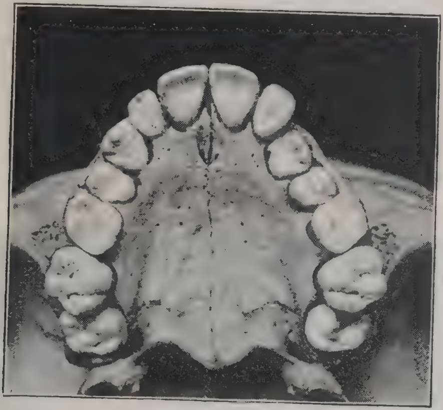


FIG. 401.

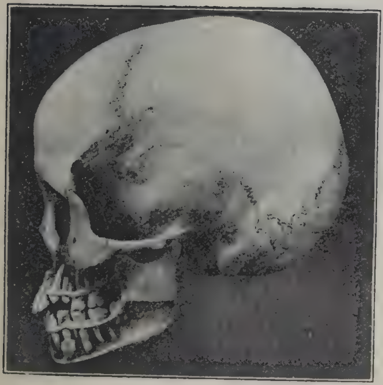


FIG. 402.—Skull of a child about 10 years of age showing superior protrusion.

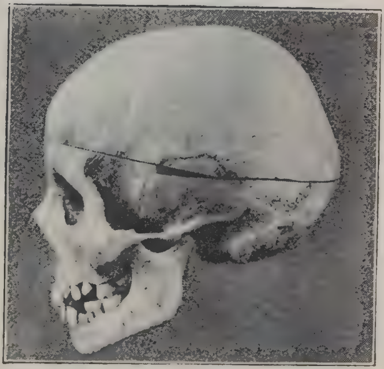


FIG. 403.—Normal skull of a child about 10 years of age for comparison with the skull shown in fig. 402.

is not fully developed the premolars and molars fail to erupt fully, and the result is that the lower incisors being on a higher level exert undue pressure in a forward direction on the backs of the upper incisors.

Group 6.—The greater part of the maxillary teeth occlude external to the mandibular teeth (see fig. 404). The pathology of these cases is obscure. The irregularity may be due to over-development of the maxilla or under-development of the mandible.

In cases of superior protrusion the deformity increases as the child approaches the age of 12 years. This is due to the pressure from the erupting canines.

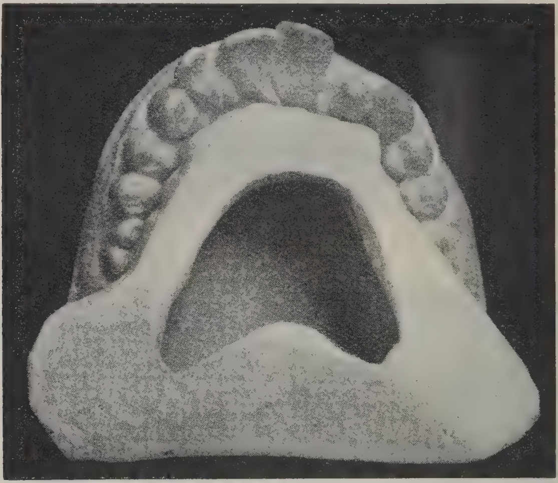


Fig. 404.

(2) *Treatment.*

When the jaws are well formed, the occlusion of the cheek teeth normal and the upper incisors well spaced, the only treatment required is the retraction of the incisors and their retention in the corrected position.

In all other cases it is advisable to make room in the arch by the extraction of teeth before commencing to retract the incisors. For the purpose of describing the treatment of these cases it will be convenient to divide them into two groups, namely, those in which the lower incisors do not impinge upon the cingula of the upper incisors or upon the gum posterior to those teeth, and those in which they do impinge on one or the other.

As a preliminary to treatment the jaws should be radiographed to ascertain (1) the position of the canines in relation to the first premolars and the second incisors, and (2) the presence or absence of the second premolars.

(i) Cases in which the Lower Incisors do not impinge on the Cingula of the Upper Incisors.—(*a*) *Where the first permanent molars are savable.* The method of treatment will depend upon the presence or absence of the second premolars and the relation of the canines to the second incisors. We will first consider the **cases where the second premolars are present and the canines are in a position favourable for being moved backwards.** In discussing protrusion of the upper teeth, attention has already been drawn to the following facts:—

(*α*) The condition is often accompanied by a certain degree of abnormal growth of the bone, which disturbs the normal relation between the jaws and the teeth.

(*β*) The maxillary, and not the mandibular, arch is at fault in the majority of cases.

(*γ*) The protrusion increases rapidly with the eruption of the canines.

These facts suggest that extraction of teeth to relieve the crowding, and extraction at an early age, is the best treatment. Treatment by early extraction certainly gives the most permanent and satisfactory results. Nevertheless it is not universally supported, and many practitioners deprecate any attempt at correction until the second permanent molars and the canines have erupted. It is not easy to discover any advantage that will accrue by postponing treatment, while the disadvantages of delay are obvious, namely:—

(1) The canine in erupting will move forward and accentuate both the protrusion of the incisors and the crowding of their roots.

(2) When treatment is commenced, the canine must be retracted by mechanical means, and in this process, instead of moving bodily back and so giving true relief to the pressure in the front of the mouth, the crown only will swing backwards, leaving the upper end of the root in much the same position as it erupted. The roots of the anterior teeth will thus remain more or less crowded and there will consequently be a constant tendency for the crowns to relapse into their former position.

(3) The retraction of the incisors will later on take a longer time, partly because the protrusion will have become more pronounced, and partly because the alveolar process will be more resistant.

(4) Owing to the prolonged mechanical treatment which will

become necessary, disorganization of molar and premolar occlusion is more likely to ensue.

With treatment carried out before the eruption of the canines, these teeth will erupt well back, pressure will immediately be taken off the incisors, the protrusion will not increase, and the mechanical treatment necessary will be slight. Still further, the teeth will come into good alignment, and the tendency to relapse will be

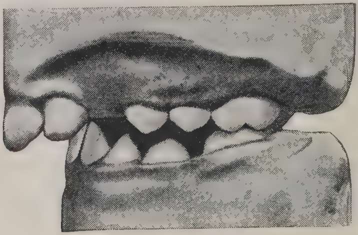


FIG. 405. Before treatment.

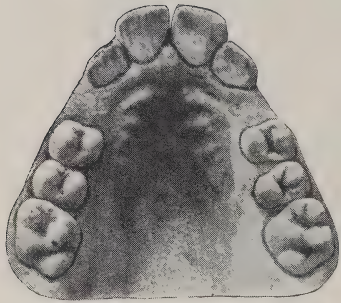


FIG. 406.—Before treatment.

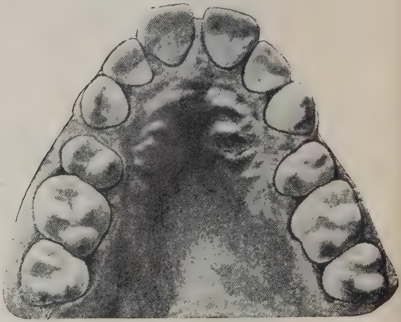


FIG. 407.—Stage at which mechanical retraction of the teeth was commenced.

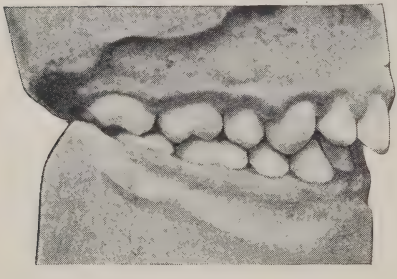


FIG. 408.

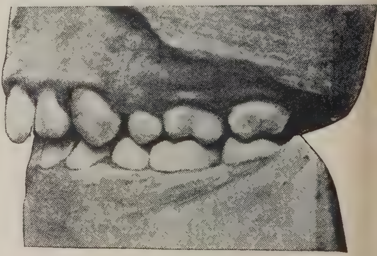


FIG. 409.

Case shown in figs. 405 and 406. After treatment.

reduced to a minimum. If early treatment is adopted, adequate space for the canines should be obtained by removing the unerupted first premolars as soon as the canines show signs of erupting. The method of carrying out this operation has been referred to on p. 238.

After the removal of the premolars, the case should be left alone until the canines have fully erupted, but the patient should be strongly urged to keep the lower lip in front of the upper teeth. Occasionally, this simple expedient is sufficient to bring about a complete cure of the case. The effect of removing the pressure of the canines on the incisors is interesting. The second incisors soon show a tendency to travel backwards, and this movement indicates a complete relief of the crowding of the anterior teeth. The incisors are eventually brought in with a simple mechanical contrivance, the teeth being retained in position until after the second permanent molars have erupted.

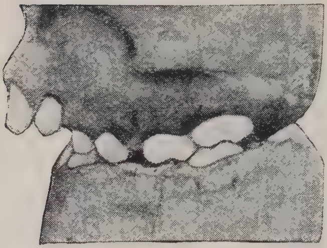
With regard to the lower teeth, the treatment must depend on the condition existing. If they are crowded, the first premolars must be removed, but their removal should be delayed until the canines have commenced to erupt. Little advantage is gained by removing the mandibular premolars at an early age, and in this respect the treatment differs from that recommended in the case of the maxilla.

When superior protrusion is treated at an early age excellent results are obtained; there is no tendency to recur; the amount of mechanical treatment necessary is trifling, and the occlusion of the premolars and molars is good. The cases shown in figs. 405 to 413 are examples of this mode of treatment.

In cases where the *roots of the canines are placed towards the middle line or lie anterior to the roots of the second incisors* the best plan is to extract the second incisors and the deciduous canines before the permanent canines show signs of erupting. The case should then be left alone until the canines have fully erupted, when the first incisors can be retracted. The objection to the removal of second incisors was discussed on p. 245.

If the second premolars are missing it is advisable to extract the first and second deciduous molars as early as possible, and then insert an appliance to prevent the first permanent molars from moving forward. The removal of the deciduous molars will allow the first premolars and canines to move backwards and so relieve the pressure on the anterior part of the arch. The retraction of the incisors should be delayed until the permanent canines have fully erupted.

If the second incisors are missing the deciduous second incisors



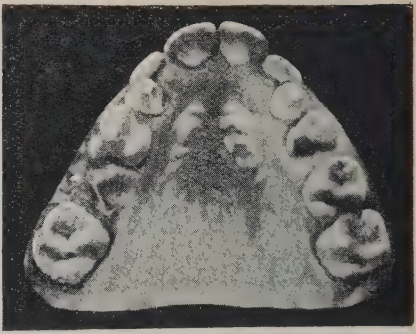


FIG. 410. FIG. 411.

Before treatment.

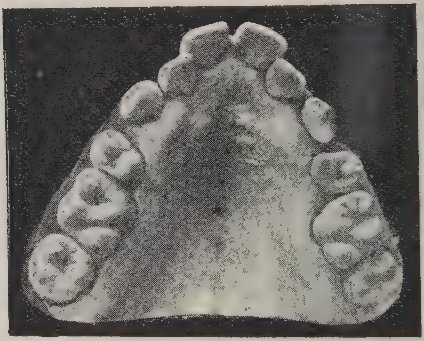


FIG. 412.

Stage at which mechanical retraction of the teeth was commenced.

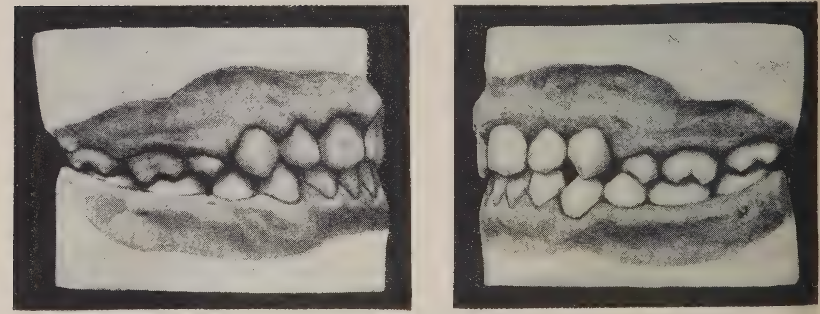


FIG. 413.

Case shown in figs. 410 and 411. After treatment.

and canines should be extracted at an early age, and when the permanent canines have fully erupted the first incisors should be retracted. If the second incisors are missing and there is risk of spaces remaining between the canines and the posterior teeth it may be advisable to extract the deciduous molars and so permit the first permanent molars to move forward and assist in closing the spaces.

(*b*) *When the first permanent molars are unsavable.*—The extraction of the upper teeth may be undertaken as soon as the second permanent molars are sufficiently through to allow of their retention in position by means of a splint plate (fig. 312). This plate, as before mentioned, will prevent the second molars from moving forward, and will allow them to erupt fully. It will also permit the premolars to travel back, provided that the bite of the lower incisors on the plate is so arranged that the premolars, upper and lower, are separated from one another during occlusion. No attempt should be made to move back the premolars by mechanical means until the second permanent molars are firmly implanted, as the molars are liable to move forward if mechanical force is used too soon.

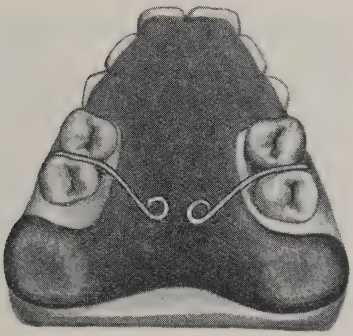


Fig. 414.

For retracting the premolars, a plate similar to that shown in fig. 414 may be used. It is important that the plate should occlude correctly with the lower teeth in order that its rigidity may be augmented. It is advisable to retract only one premolar on each side at a time. If both premolars are retracted simultaneously, the second molar is very likely to move forward, as the resistance offered by two premolars is frequently greater than that of one molar, especially if the latter is not fully erupted. The premolars should be moved far enough back to allow the anterior planes of the upper teeth to strike the posterior planes of the lower teeth, otherwise the posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation to persist (see figs. 415 to 417). If possible, the lower first molars should be retained until the premolars in the upper have been brought into correct occlusion. When the premolars are sufficiently retracted, the canines and then the incisors may be treated.

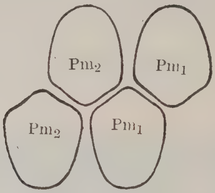


Fig. 415.—Diagram of articulation of superior protrusion cases which often require retraction of the upper premolars.

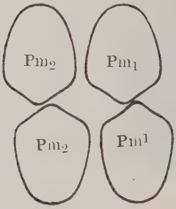


Fig. 416.—Diagram to illustrate the least extent to which upper teeth must be retracted. The posterior plane of the lower teeth will tend to drive the upper teeth backwards.

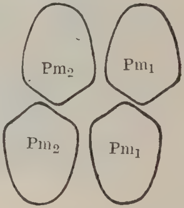


Fig. 417.—Diagram to illustrate insufficient retraction of upper teeth. The posterior planes of the upper teeth will tend to drive the lower teeth backwards and the abnormal articulation of the premolars will persist.

The results obtained are not very satisfactory, as there is usually a tendency to relapse, due in a measure to the fact that extraction of the molars gives but little relief to the crowding of the anterior teeth.

With excessive protrusion and unsavable first molars, it may be necessary to remove the first premolars, in addition to the first molars. The molars must be removed because they are unsavable, but their removal will not materially aid in the treatment of the protrusion. If the protrusion is left alone, the teeth are almost certain to be lost at an early age from periodontal disease. If the protrusion is to be treated with any hope of obtaining a permanent result, the premolars must be removed, and, when the one alternative is weighed against the other, the advantage would seem to be in favour of the extraction of the premolars and the permanent retention of the front teeth.

When the first permanent molars are unsavable and the second incisors are absent or the canines are placed in an unfavourable position for moving backwards, the extraction of the molars should be carried out before the eruption of the second molars in order that these teeth may move forward in contact with the second premolars. The remainder of the treatment should follow the lines suggested on p. 279.

In cases of superior protrusion which are not seen until after the canines have erupted, a prolonged spell of mechanical treatment is usually necessary, and the results obtained are often far from satisfactory.

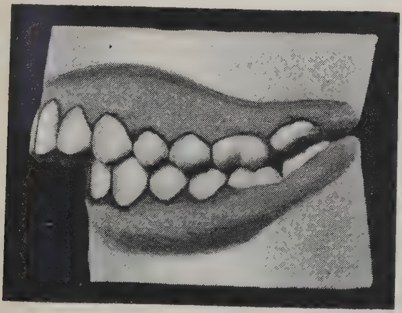


Fig. 418.

In the foregoing account, treatment has been based on the principle of creating a space on either side of the arch and bringing the front segment backwards. Some practitioners maintain that cases of protrusion can best be treated by "*jumping the bite*," and base their treatment on the assumption that the position of the maxillary teeth is normal and that the trouble is due to a retraction of the mandible. For example, in the case fig. 418 the mandibular premolars and molars are nearly the width of a premolar behind the correct occlusion. If the patient can be made to acquire the permanent habit of bringing the mandible forward so as to make the teeth articulate normally, the bite will have been "jumped." The subject is one which has been voluminously written upon, and on which there is much diversity of opinion. The means usually employed is to adapt to the upper jaw a plate at the anterior part of which is an inclined plane shaped to bring the mandible forward in the act of closing the mouth.

It is clear from the cases recorded that patients can be made to acquire, at least temporarily, the habit of protruding the jaw, and thus "jumping the bite." Does this habit become permanent, and, if so, what structural changes take place in the parts involved? By some[1] it is maintained that changes take place in the glenoid cavity (1) by an extension of the condyle of the mandible, which practically amounts to a bending backwards of the neck; (2) by the filling up of the cavity posterior to the condyle. These explanations do not seem compatible with our knowledge of the anatomy and physiology of the temporo-mandibular articulation. A more likely explanation is that the teeth move forward in the sockets.

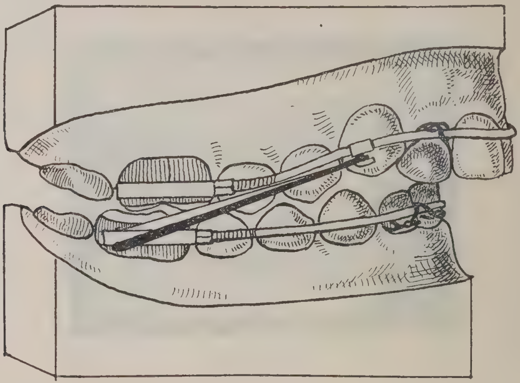


FIG. 419.

When the teeth are occluded in the new position, namely, with the bite jumped, the muscles must constantly tend to retract the mandible to its old position; this backward tendency is arrested by the upper teeth, with the result that the lower teeth are drawn forward in their sockets and absorption and re-disposition of bone in the tooth sockets take place as when a tooth is moved by mechanical means.

E. H. Angle,[2] in referring to this point, states that cases examined four years after the termination of treatment show the backward tilt of the upper teeth and the forward tilt of the lower ones.

Some practitioners treat cases similar to that shown in fig. 418

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[1] See *Trans. World's Columbian Dental Congress*, vol. ii, p. 760.

[2] "The Treatment of Mal-occlusion of the Teeth." Seventh Edition.

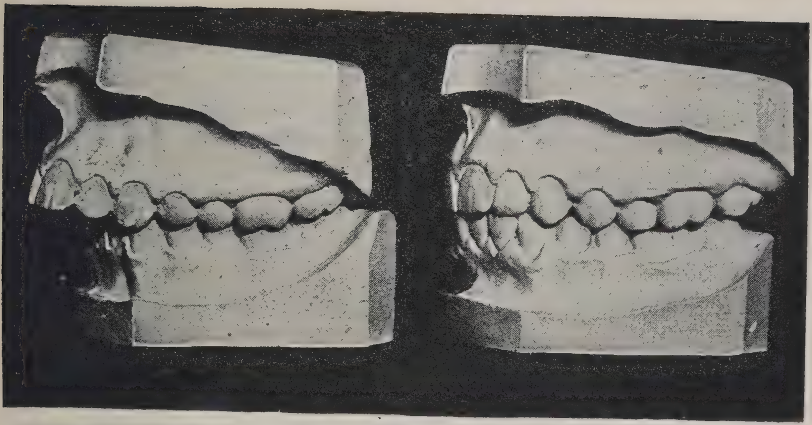

FIG. 420.[1]

Left side.

Before treatment. After treatment.

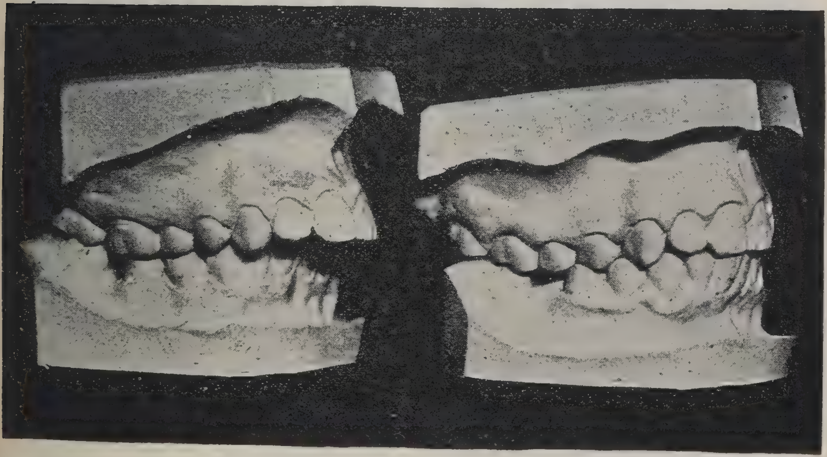

FIG. 421.[1]

Right side.

Before treatment. After treatment.

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[1] From "Operative Dentistry," by C. N. Johnson.

by means of intermaxillary traction. Expansion arches are adjusted to both jaws, and the teeth are spread to the desired position; the expansion arches are then connected by elastic bands, as shown in fig. 419. It is claimed that by these means the lower teeth can be easily moved forwards and the upper backwards. When the teeth are in normal occlusion, a retention apparatus is applied. The models of a case treated in this way are shown in figs. 420 and 421. A careful examination of the models shows that although the premolars were brought into correct occlusion the second molars have been rendered almost functionless.

Where the protrusion is complicated by tilting of the second incisors it is difficult to obtain permanent results. The crowns of the incisors are arranged in a fair arch, but in such a way that the roots of the second incisors lie towards the median line. This condition is probably the result of adenoids, or some other form of nasal obstruction. The anterior nares, being functionless, do not develop properly, and so indirectly, and perhaps directly, affect the growth of the premaxillæ. In these cases the canines come down in such a way that their roots lie towards the median line. Retractive measures will draw back the crown, but the pressure on the root of the second incisor is not relieved, indeed, may even be increased. The space gained in the arch by the retraction of the canines will admit of retraction of the incisors to a certain extent, but the effect of retraction of the incisors is that their roots will become

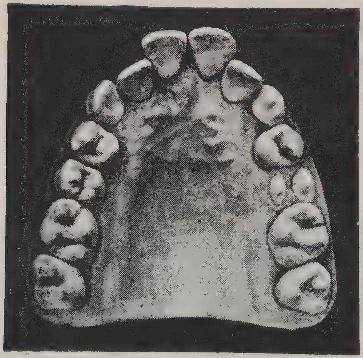

Fig. 422.[1]

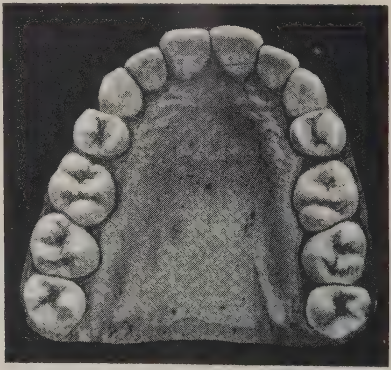

Fig. 423.
Case shown in fig. 422 after treatment.

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[1] The patient was hand-fed and suffered from adenoids which had not been treated.

still more crowded, and there will be a strong tendency to relapse unless a retention plate is regularly worn at night. The choice lies between (1) leaving the case alone, with the inevitable result that the condition becomes worse and periodontal disease supervenes; and (2) treating the case, and, after the teeth are retracted, impressing on the patient the necessity of wearing a retention plate at night.

In the case shown in figs. 422 and 423 the second incisors have been forced slightly behind the first incisors. The first premolars were removed and the anterior teeth retracted. At the age of twenty-five (fig. 423) there was still a tendency for the teeth to relapse to their former positions unless the retention apparatus was worn at night.

Where there has been considerable interference with the growth of the premaxillæ so that the root of the second incisor is covered by that of the canine, by far the most satisfactory results are obtained by the extraction of the second incisors. A typical case is shown in fig. 424.

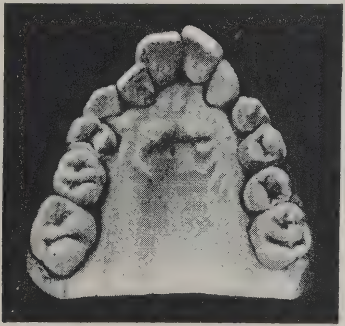

FIG. 424.[1]

(ii) Where the Lower Incisors impinge on the Cingula of the Upper Incisors, or on the Gum Posterior to these Teeth.—These cases are difficult to treat and the results obtained are frequently unsatisfactory. If the mouth of a patient presenting this form of superior protrusion be examined, it will be noticed that the lower incisors are on a higher level than the premolars and molars. This may be due to some abnormal condition of the incisors, the height of the premolars and molars being normal; or the incisors may be normal in their arrangement and the premolars and molars unduly short; or again, both incisors, premolars and molars may be at fault. In order *that treatment may be successful, it is essential that the lower incisors should not impinge on the cingula of the upper incisors when the latter have been retracted.* It is therefore needful that attention should be directed to the treatment of the lower teeth. It has already been pointed out that the abnormal uprising of the lower incisors is due to crowding from lateral pressure of the canines, and that the shortness of the range of the molars and premolars probably arises from a defect in the development of the bones. As a first step in treatment, most practitioners endeavour to raise the bite—in other words, induce the molars and premolars to elongate and so prevent the lower incisors from impinging upon the cingula of the upper teeth. There are two strong *objections to treatment by raising the bite:* (1) the obstinacy, at times, on the part of the molars and premolars to rise; and (2) their liability to relapse by being forced down again into their sockets. It is not surprising that disappointment attends the practice of " bite raising," since the treatment is not in accord with our anatomical knowledge of the condition. *Failure to raise the bite* seems more likely to occur in cases where the molar and premolar region is well developed. There is a common impression that if teeth are separated from one another they will always elongate. That this view is erroneous will readily be seen by a study of that type of irregularity called " open bite."' When the ramus is short, the premolars and molars are probably prevented from rising to their normal height. If, therefore, the jaws are separated, the teeth will no doubt rise. It is in these cases that the liability to relapse occurs. Raising the bite does not in any way affect the ramus, which is probably the real cause of trouble. The mouth is in reality propped open artificially and the muscles which close the mandible are in a state of tension. As soon as the plate is removed, the muscles have again free play and the pressure they exert drives back the premolars and molars to their original positions.

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[1] The patient was hand-fed, a tube bottle being used; she had also suffered from adenoids. The adenoids were probably responsible for the interference with the growth of the premaxillæ, and the marked narrowing of the arch was probably due to the use of the tube bottle.

In a few cases, with the eruption of the second molars, the bite becomes raised by natural means, probably from a rapid growth of the ramus about this period, and it is possible that where the bite has been raised by artificial methods the same natural causes have contributed to the results obtained.

More reliable results can be obtained by directing treatment to the mandibular incisors. Where the incisors and canines are not very crowded, their cutting edges should be ground down until they are clear of the upper teeth; at the same time it is most important that all lateral pressure should be relieved by the removal of a premolar or molar. If this is not done, there is a risk that when the third molars erupt they will exert a forward pressure and cause crowding of the front teeth. Where the incisors are very crowded,

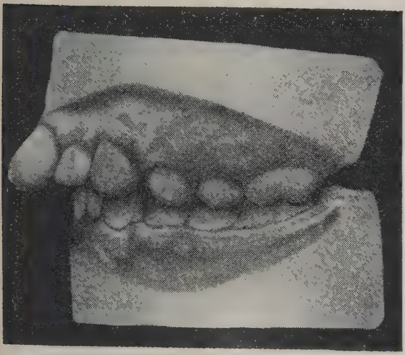

FIG. 425.—Left side before treatment.

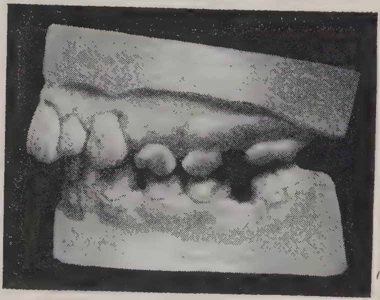

FIG. 426.—Left side after treatment.

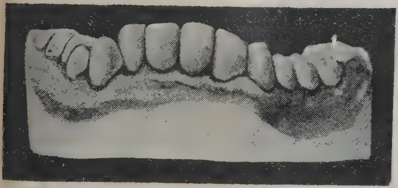

FIG. 427.
Lower incisors before treatment.

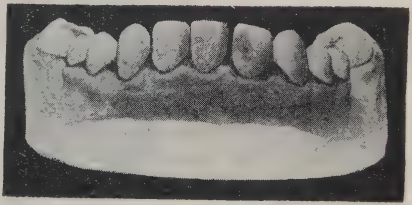

FIG. 428.
Lower incisors after treatment.

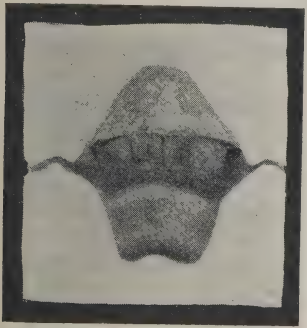

FIG. 429.—Showing relation of the lower incisors to the upper teeth at the commencement of treatment.

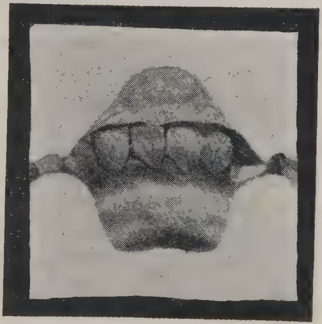

FIG. 430.—Showing relation of lower to upper incisors after treatment.

with the canines lying slightly anterior to the second incisors, or where the fan-shaped arrangement is well marked, it is an excellent plan to remove an incisor. The crowding of the remaining teeth is efficiently relieved and the incisors usually fall to their normal level and are so prevented from impinging upon the upper gums or teeth. Removal of an incisor slightly narrows the lower arch, and this is, in my opinion, a distinct gain as far as treatment is concerned. Some, however, maintain that the narrowing of the arch may be detrimental to the facial expression because it will allow the lower lip to fall in. This view is incorrect. The prominence of the chin is governed by the mental process and is in no way dependent upon the alveolar portion of the jaw, which is alone involved in the removal of an incisor. When the upper teeth have been retracted the lower lip should close outside them and should not be dependent upon the arch of the lower incisors for its position. A case treated in this manner is shown in figs. 425 to 430. The amount of protrusion is shown in fig. 425.

An examination of the models shows that as regards occlusion with the lower teeth the right upper premolars are erupting normally; on the left the upper premolars are not quite half a tooth in advance of their correct positions, the anterior planes of the upper teeth just striking the posterior planes of the lower teeth. The lower incisors are crowded and show the typical heaped-up appearance already alluded to (fig. 427). The cutting edges of these lower incisors strike the gum just posterior to the upper incisors (fig. 429). The direction of the roots of the lower incisor teeth indicated that the left first incisor should be removed. This tooth having been extracted, the case was left for a year, as the first permanent molars, which were unsavable, had to be removed, and this could not be done when the patient was first seen, as the upper second molars had not then erupted. When examined one year afterwards, the gap caused by the removal of the lower first incisor had closed up, the teeth had apparently dropped down to a lower level (see fig. 428), and were quite free from the upper gum. By the removal, therefore, of this first incisor one of the great difficulties in treating this type of case had been overcome. The first permanent molars were now extracted and a splint plate put in to keep the second permanent molars from moving forward and at the same time allow the premolars to travel back. The canines were then retracted and the incisors brought in. The result is seen in figs. 426 and 430. The lower incisors are quite clear of the upper teeth and the lower lip also passes in front of them. The upper teeth could have been retracted still more, but this was not considered advisable for æsthetic reasons. The case has shown no tendency to relapse.

The question whether, after treatment, cases of superior protrusion tend to relapse has long been the subject of much controversy. It may, however, be safely predicted that there will be no tendency to relapse if we can—

(1) Ensure that the lower lip in occlusion passes in front of the upper incisors.

(2) Ensure that the lower incisors do not press unduly upon the backs of the upper incisors.

(3) Prevent crowding of the upper incisors and canines.

The tendency to relapse will be in proportion to the failure to overcome these difficulties.

(B) INFERIOR PROTRUSION—UNDERHUNG BITE

In this condition, when the mouth is closed, the upper front teeth pass within the arch of the lower teeth, instead of outside it; in other words, the mandible protrudes. This abnormal arrangement of the teeth may be limited to the incisors and canines, or may involve the premolars and molars as well. Protrusion of the mandible is a natural condition in the edentulous.

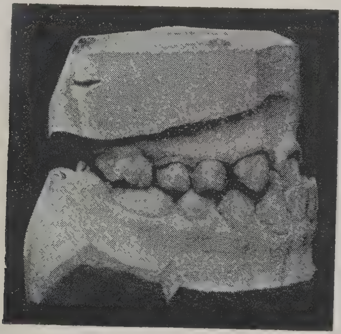

FIG. 431.[1]

Etiology and Pathology.—In the more simple examples of inferior protrusion the irregularity is due to a faulty occlusion of the teeth in jaws otherwise well developed; but in other cases it arises from faulty growth of the bones themselves.

In the *first group* may be included those examples which are traceable to *habits*, one of which is *the constant protrusion of the mandible* and another the *hooking of the fingers over the lower teeth* causing a forward movement of the incisors until they occlude anterior to the upper teeth.

In a definite variety of cases the irregularity is due to the *eruption of the upper permanent incisors internal to the existing deciduous teeth*. The permanent incisors, when fully erupted, pass behind the lower incisors and the latter assume a more forward position. The permanent maxillary canines in erupting move slightly towards the median line and, as it were, lock the incisors. Cases of this character are recognized by the general direction of the incisors, the upper teeth sloping backward and the lower teeth forward. The occlusion of the premolars and molars is usually normal. In fig. 431 is shown an example of this type of protrusion.

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[1] From "Text-book of Operative Dentistry" (Kirk).

In the *second group* the etiology and pathology are frequently obscure. In many cases the trouble can be traced to a *defective growth of the maxilla* associated with adenoids. The lack of growth may be limited to the premaxillæ so that the only teeth involved in the deformity are the incisors, or the maxillæ may be generally affected. An examination of the mandible will not disclose any defect of growth.

The most obscure cases are those in which the *defect is traceable to the mandible.* In some examples the mandible seems to be unduly large, the relation of the body of the bone to the ramus being normal. In others the protrusion appears to arise from a thrusting forward of the body of the bone due to an excessive growth of the ramus. In the skulls shown in fig. 432 this abnormality is well shown. It will be noted that in the skull marked (A) the mental process is unduly prominent, a condition not infrequently seen in these cases. An examination of the skulls will also show that the condyle of the mandible articulates correctly in the glenoid cavity. This variety of inferior protrusion is occasionally transmitted through generations, a classical example being seen in the Hapsburg royal line.

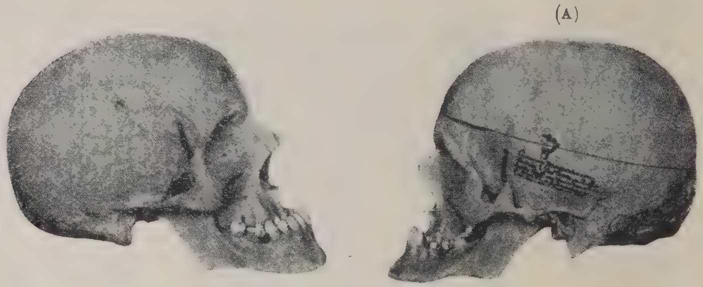

FIG. 432.

Fig. 433 shows the models of a case of inferior protrusion due to defective growth of the mandible. The lower teeth in occlusion are in advance of the normal. Fig. 434 represents the models of a boy aged five years, showing well-marked protrusion of the mandible.

In some cases of forward bite, however, the articulation of the condyle is not normal, and in fig. 435 the condyle rests on the eminentia articularis. M. Cryer,[1] who drew attention to this peculiarity, inclines to the view that the abnormal position of the condyle in these cases may be due to the use of forceps at birth; the mandible, he thinks, may have been drawn forward, and, if the

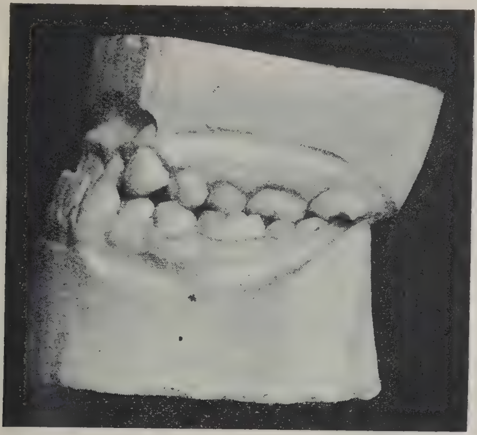

FIG. 433.

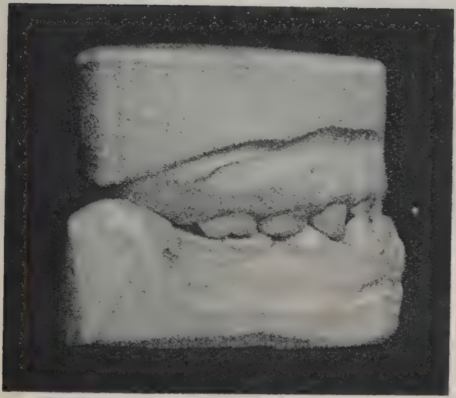

FIG. 434.

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[1] *Dental Cosmos,* November, 1906.

displacement is not subsequently reduced, the temporo-mandibular articulation will be changed from the glenoid fossa to such position as the condyles may assume.

L. S. Chilcott[1] thinks that similar injury may follow difficult "breech presentation" cases. Cryer also quotes a case of forward bite associated with mal-position of the condyles in a man aged thirty-five, who had been a case of breech presentation.

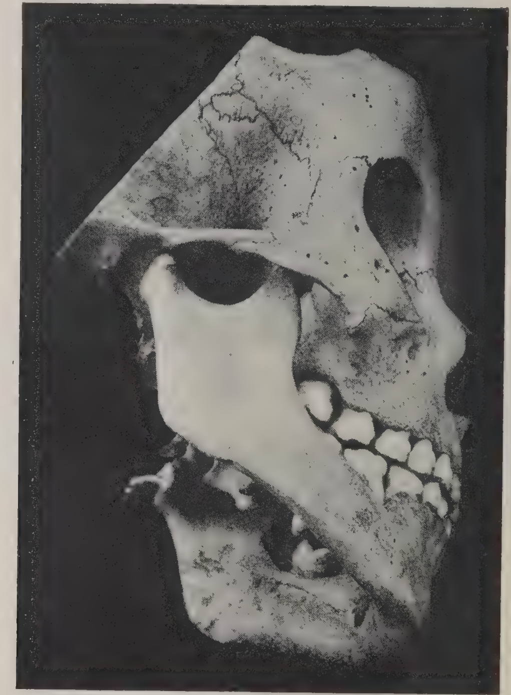

FIG. 435.

In acromegaly the mandible is frequently found enlarged.

In examining patients showing inferior protrusion, it will often be noticed that when the jaws are in repose the upper and lower incisors are in contact, leaving a space between the opposing premolars and molars, but during mastication the mandible is brought forward to obtain the necessary occlusion of the posterior teeth. This point should be remembered when cases are being examined with the object of ascertaining how far back the mandible can be taken.

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[1] *Dental Cosmos*, March, 1906.

Treatment

In a few cases the condition is cured by natural means; this happened in the boy whose models are shown in fig. 434. No treatment was adopted, but by the age of sixteen he presented the condition shown in fig. 436.

Where the irregularity is limited to the dental arches the mandibular incisors may be brought into correct position by mechanical means. A plate capping the mandibular premolars and molars, with a half-round gold wire impinging on the labial surfaces of the protruding teeth, will usually suffice.

If the protrusion is due to habitual thrusting forward of the mandible, the child must be broken of the habit and a skull and chin cap, similar to that shown in fig. 437, must be worn day and night. Cases of this type are curable.

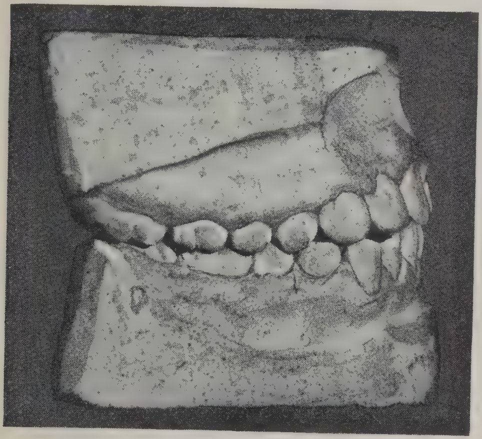

FIG. 436.

In cases due to faulty growth of the jaw, the treatment adopted must depend in a very great measure upon the cause and extent of the deformity.

Where the fault is traceable to the maxillæ and the irregularity is slight, an expansion of the upper arch will often result in considerable improvement and at times in complete correction of the irregularity. Where the irregularity is more marked it is desirable that, in addition to expanding the upper arch, an endeavour should be made to reduce the arch of the lower teeth by the extraction of an incisor or the first premolars. By this treatment it is often possible to make the arch of the maxillary teeth pass beyond that of the mandibular teeth, but, although some slight improvement in the expression may be gained, too frequently the treatment causes a complete disorganization of the articulation between the teeth. Further, the superior teeth, even though they may be in a plane anterior to the inferior, do not overlap, the result being that a retention plate must be worn for a prolonged period to keep them in position.

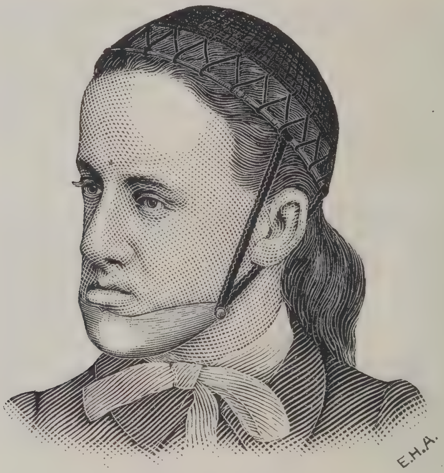

FIG. 437.[1]

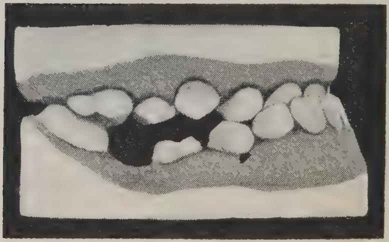

FIG. 438.

The case, the models of which are shown in fig. 438, will help to illustrate one or two points in treatment. The patient was a girl, aged fourteen. It will be seen that in complete occlusion there is a good deal of protrusion. In the mandible the first molars have been removed and in the maxilla the left upper first premolar has been removed to make room for the canine which erupted external to the arch. The superior and inferior premolars fail to occlude, the result being that the whole process of mastication has to be carried on by the molar teeth. On examining the patient, it was at once noticed that the mouth was kept slightly open, the lower incisors being brought into contact with the upper. The patient stated that this was the most comfortable position, and that, during mastication, she constantly suffered from discomfort in the region of the articulation. An examination of the articulation with the teeth in occlusion, as shown in fig. 438, demonstrated that the condyle was brought forward, and was not resting in its normal position in the glenoid cavity. The protrusion was thus to a great extent artificial, and a fair result could be anticipated with proper treatment.

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[1] From "Mal-occlusion of the Teeth," by E. H. Angle.

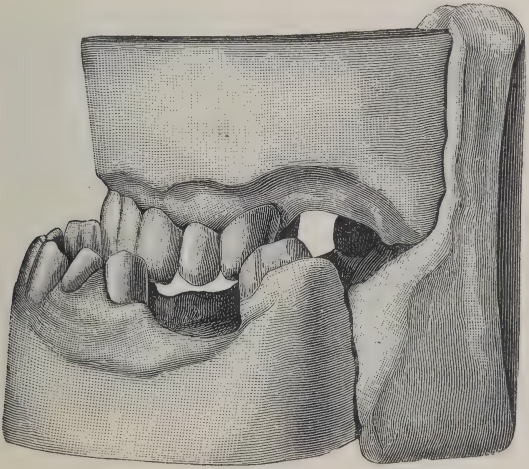

Fig. 439.

The lines on which treatment in such a case should be carried out are as follows: The anterior superior teeth should be brought forward and a biting apparatus inserted in the lower.

In cases such as that shown in fig. 439 the deformity is greatly exaggerated by the loss of the posterior teeth. The insertion of artificial dentures will not only assist in restoring the masticating area, but, if the bite is raised, will hide the deformity to some extent.

When the protrusion of the mandible is so marked that the upper teeth bite completely within the arch of the lower, steps should be taken to procure a masticating area. This may be effected by the insertion of dentures, the exact plan to be followed in each case depending upon circumstances. In severe types of inferior protrusion, similar to those just referred to, it might be possible to improve the condition by surgical means. Several cases have been reported where surgical treatment has been adopted.

In considering the advisability of adopting resection of the mandible, the pros and cons must be carefully weighed. Resection of the mandible is always an operation attended by considerable risk, and even if the resected parts unite, the occlusion of the teeth is very likely to be so defective as to necessitate the use of dentures. It would therefore seem that by resection we cannot rely on gaining more than an improvement in appearance. Whether it is justifiable to submit the patient to the risks of a severe operation in the hope of gaining some improvement in personal appearance is a doubtful question.

When it is necessary to obtain a masticating surface, the better plan would certainly seem to be to disregard the question of appearance and treat the case by the insertion of dentures. In one case under my care (a young girl) the question of resection was carefully considered, and the method suggested was the resection of the mandible in the median line in preference to resection on either side. Treatment on these lines would be attended with less risk than bilateral section of the mandible.

Cross Bite.—Cases in which there is unilateral protrusion of the lower teeth—a condition familiarly known as "cross bite"—may conveniently be included in this section. This irregularity may be traced to habit, or may arise from a defective growth of the maxillæ, the "cross bite" being acquired by the child in its efforts to obtain occlusion of the premolars and molars.

When the irregularity is due to habit, an apparatus may be contrived to counteract the habit and so restore the normal occlusion. Where, however, the "cross bite" arises from want of proper growth of the maxilla, an improvement may be obtained by an expansion of the upper arch.

(C) LACK OF OCCLUSION—"OPEN BITE"

This term is applied to that abnormality in which the back teeth alone occlude when the mouth is closed.

From a clinical point of view "open bite" may be considered under three groups:—

(1) Where the premolars and the molars occlude, but the cutting edges of the upper and lower anterior teeth are separated from one another by a space more or less oval in shape.

(2) Where the majority of the posterior teeth, as well as the anterior teeth, fail to occlude.

(3) Where there is partial lack of occlusion in the premolar and molar regions.

Etiology and Pathology.—In group (1) the deformity is invariably the result of an acquired habit, such as thumb- or finger-sucking, the thumb or finger being bent and inserted horizontally between the cutting edges of the upper and lower teeth. The pressure thus exerted forces the upper teeth, as well as the alveolar process, in a direction upwards and slightly outwards. The lower teeth are forced downwards, but their displacement is far less marked than in the upper.

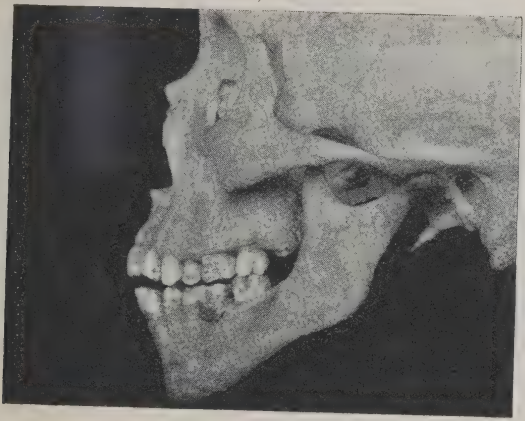

FIG. 440.[1]

Cases included under group (2) vary greatly in the degree of their severity, so that while in some cases the irregularity may consist merely of a slight separation between the teeth, in others it may extend to the condition shown in fig. 440. This type of "open bite" is invariably accompanied by a marked narrowing in the region of the premolars and molars. In twenty-four measurements taken, the averages were 30·56 mm. between the first molars and 21·35 mm. between the first premolars. Compared with normal breast-fed children, the width across the molars and premolars is 100: 88·4 and 100: 80·7, respectively. The occlusion of the teeth is not so abnormal as in superior protrusion, only a small percentage showing the "too forward occlusion." Hypoplastic teeth are invariably present, the condition often being very marked, and there is almost always a history of long-standing adenoids. The maxilla is defectively developed, the arch in the region of the molars and premolars being often within that of the mandibular teeth. In one section of these cases the opening increases progressively from behind forward; in another section, there seems to be marked bending down of the lower arch in the region of the first mandibular molar; while in a third section the mal-occlusion is considerably accentuated in front by an upward curvature of the maxillary incisors; and a fourth section is found to combine the defects of sections 2 and 3. Unfortunately, morbid anatomy specimens of "open bite" are rare. Fig. 440 illustrates certain points noticeable in many of the cases, namely, an unusual growth of the anterior part of the mandible; a short sloping ramus, and a marked bending of the mandible at a point near the spot where the facial artery crosses the bone. The pathology of the condition is obscure. H. Schmidt, as quoted by H. Baldwin,[1] considers that when the mouth is kept open, as in marked nasal obstruction, the tongue is held down to the floor of the mouth and the tongue's tip is pressed against the front part of the lower jaw and teeth, exerting a downward and forward pressure. This pressure, operating on yielding bone, causes the alteration of the angle and so produces the deformity.

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[1] From a photograph by J. E. Grevers.

The constant presence of adenoids and the association of the condition with hypoplastic teeth, which must be regarded as a sign of previous rickets, suggest that "open bite" is due to the ill-effects of adenoids in conjunction with rickets. We know that the weight of the cheeks tends to narrow the jaw, and if this weight is acting on easily pliable bones the effect will be more pronounced. This will account for the marked narrowing of the arch. In severe cases, the mandible takes a marked bend downwards, near the anterior border of the masseter, and this condition is probably due to a bending of the bones caused by the downward pull of the muscles which open the mandible, counteracted by the elevators of the mandible. The upward displacement of the maxillary incisors is probably due to the action of the comforter, or the teat of the bottle, on bones softened by rickets. In other words, the agencies which produce general crowding and protrusion, when combined with rickets, produce grosser lesions which show themselves in the form of "open bite."

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[1] *Dental Record*, vol. ix, p. 147.

The cause of *partial lack of occlusion* in the premolar and molar region is often obscure. In a few cases, faulty extraction may be responsible for the condition.

Treatment

It is impossible to lay down any hard-and-fast rules for the treatment of "open bite," as each case must of necessity be considered on its merits.

Class (1), namely, **where the deformity is limited to the anterior teeth.** When seen at an early age, before the eruption of the permanent teeth, much may be done by breaking the patient of any vicious habits that may have been acquired, and, with the eruption of the permanent teeth, the condition will be improved to some extent. When the habit of thumb-sucking, &c., has been continued during the eruption of the second dentition, or when the deformity is severe, treatment is of little avail. But it should be remembered that, although the appearance of the patient may be a little unsightly, the premolars and molars articulate, and the posterior teeth can, therefore, adequately perform their function of mastication. In these circumstances, it is generally better not to interfere, although, where the personal appearance is of the first importance, the crowning of the upper six anterior teeth might be deemed advisable. In a very severe case crowning would hardly be practicable, and it would be preferable to remove the anterior teeth and insert a denture.

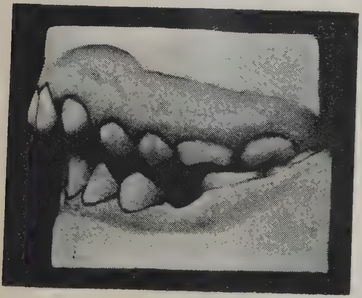

FIG. 441.

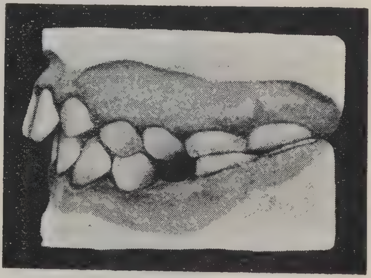

FIG. 442.

Class (2), namely, **where the majority of the posterior teeth fail to occlude.** A considerable improvement may be made in many cases by cutting in the bite. This method is extremely satisfactory, and may be employed alone or in combination with either extraction or the skull and chin cap. The treatment consists in grinding down the teeth until the premolars and molars articulate. This operation might with advantage be more generally adopted. The points in its favour are: (1) It gives the patient a good surface for mastication; (2) it is permanent—teeth forced down by the skull and chin cap tend to rise again as soon as the apparatus is discarded; (3) it relieves the patient of a long and tedious course of treatment.

The operation should extend over several sittings, and a fair interval should be allowed to elapse between each. In the case shown in figs. 441 and 442, the treatment was spread over a period of one year. The object of leaving an interval between each sitting is that the pulp has time to react to injury caused by the operation, and the secondary dentine thus formed allows a greater portion of tooth structure to be eventually removed. The patient should be directed to apply spirits of wine to the cut surfaces twice a day, and the necessity of drying the surfaces thoroughly and keeping them entirely free from saliva for about a minute after the spirit has been applied should be emphasized. This treatment hardens

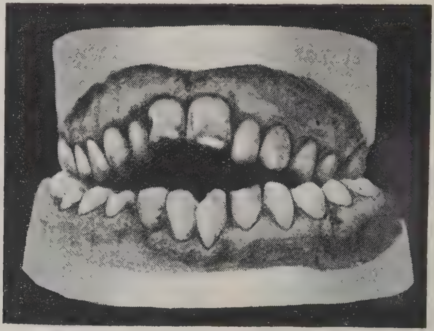

Fig. 443.

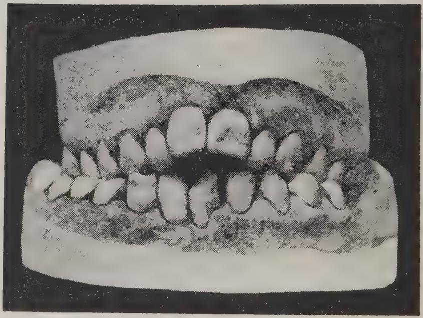

Fig. 444.

the cut surfaces of the dentine to some extent and any sensitiveness that may exist is diminished. It is also a good plan, after each sitting, to apply nitrate of silver to the cut surfaces.

Another case treated by cutting in the bite is shown in figs. 443 and 444.

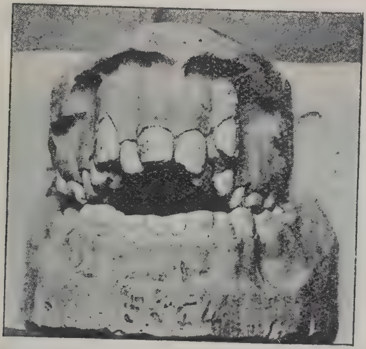

Fig. 445.—Patient, aged 21. Breast- and hand-fed fifteen months. Neave's food. Tube feeding-bottle used. Adenoids present, not treated. Teeth hypoplastic. History of rickets; no history of use of comforter or thumb-sucking.

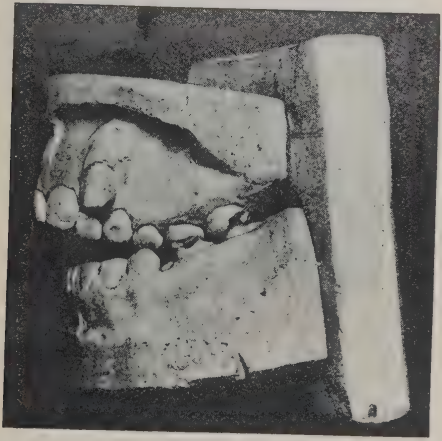

Fig 446.

Where the deformity is only slight, an attempt may be made to correct the condition by the use of the skull and chin cap. If this treatment is to succeed, the apparatus must be worn constantly and the elastic bands stretching between the chin and skull caps arranged so as to exert pressure in an upward and not a backward direction.

In most cases the removal of teeth will be necessary. The extraction of the second molars may suffice to remedy some examples, but unfortunately the first molars are generally unsavable and, in these circumstances, the removal of the second molars is hardly justifiable. Under such conditions, the following course of treatment will often yield satisfactory results. Remove the first molars and use a skull and chin cap for a period of from six months to one year. If the occlusion is then still open, the operation of "cutting in the bite" may be resorted to. Where the arch of the maxillary teeth is contracted, the occlusion may often be improved by tilting the molars and premolars outwards.

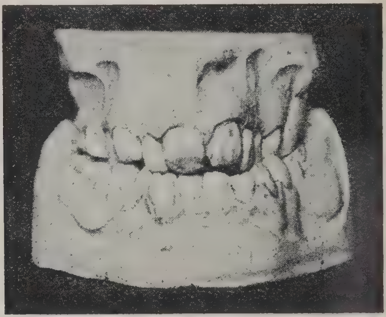

Fig. 447.

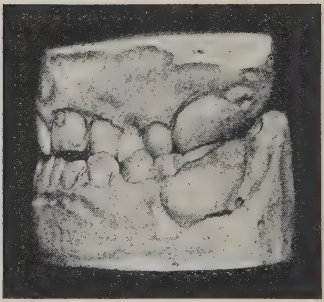

Fig. 448.

In severe forms extensive extraction must be resorted to, followed by the insertion of dentures. A typical case is shown in figs. 445 and 446. The teeth removed were $\begin{array}{l|r} 765 & 34567 \\ \hline 87\ 54 & 56 \end{array}$ and dentures were adapted with the result seen in figs. 447 and 448.

In the treatment of "open bite" some practitioners adopt the plan of shortening the molars and lengthening the incisors, canines and premolars; but such treatment cannot be relied on to give permanently good results. In connection with such treatment, it must be remembered that patients with "open bite" invariably have gingivitis of long standing, and that the numerous bands and ligatures necessary for this treatment must inevitably increase the gum lesion, indeed it is not improbable that they may give rise to serious periodontal disease.

Cases of "partial open bite" must be dealt with by some form of mechanical appliance if it is considered expedient to treat them.

(D) ABNORMALITIES OF THE TEETH ASSOCIATED WITH CONGENITAL DEFECTS OF THE JAW

This class of irregularities forms a small but well-defined group.

(i) Associated with Arrest in Development of the Mandible.—A partial arrest in the development of the mandible may occur. The effect of the malformation on the dental arches will be to draw the teeth towards the affected side and cause the lower incisors to pass well behind the upper teeth, with the result that the lower lip will fail to cover the upper teeth and a marked protrusion of these teeth will follow. In treating such irregularities, little can be done beyond reducing the upper arch and retracting the incisors.

(ii) Hare Lip.—Where the suture in the incisor region is involved, considerable irregularity of the incisors frequently follows. Great caution should be exercised in attempting the correction of these irregularities. The roots of the incisors are often malformed, and, if treatment from an æsthetic point of view is necessary, the extraction of the teeth and the insertion of a denture is usually the wisest couse to pursue.

(iii) Cleft Palate.—In cases of cleft palate complicated by hare lip, the incisors adjacent to the fissure are often misplaced, and may erupt into the nasal cavity. As a rule, it is inexpedient to attempt their regulation, the roots of such teeth being usually curved and twisted. If the condition produces great disfigurement, the teeth can be removed and a denture inserted.

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CHAPTER X

Injuries of the Teeth arising from Trauma; Concussion, Dislocation, and Fracture

(A) CONCUSSION

Concussion may give rise to slight or severe periodontitis and may be complicated by pulpitis which may lead to death of the pulp. The pulp may be ruptured from its connections at the apical foramen, and when this occurs the pulp often remains quiescent, but marked discoloration of the tooth substance usually supervenes.

(1) Causes.—Concussion of the teeth may arise from direct or indirect violence. A blow on the mouth from a fist or a cricket ball are examples of direct violence, and a blow on the chin, a fall or jumping upon the heels instead of upon the toes are examples of indirect violence.

(2) Signs and Symptoms.—In most cases of concussion of the teeth the patient will be found to be suffering from periodontitis more or less severe. Where the pulp has not been ruptured at the apical foramen, or the inflammation of the periodontal membrane has not extended to the pulp, the tooth will be found to be sensitive to pressure and will respond to thermal changes in the same way as the normal tooth. Should the inflammation spread to the pulp, the tooth will become exquisitely sensitive both to pressure and to slight variations of temperature, the periodontal pain being dull, constant, and restricted to the tooth, while the pain arising from the inflamed pulp will be of a sharp lancinating character and will be referred at times to other teeth and adjacent parts. When suppuration in the pulp occurs, the tooth will no longer be sensitive to changes of temperature, but the periodontal inflammation will increase in severity owing to the suppuration having spread to the periosteum. The pain will be of a throbbing character.

(3) Treatment.—The treatment will depend upon whether or not the pulp is involved in the injury. *When the periodontal membrane only is affected*, local depletion will be found efficacious; in mild cases, counter-irritation, with capsicum plasters, tinct. iod., will be sufficient. *When suppuration of the pulp has taken place*.

the pulp chamber must be opened in the direction which will render removal of the pulp most easy; the dead pulp must be removed and the canals treated and filled. Where concussion has caused pulp irritation, and at the end of two or three days no improvement is apparent, the pulp should be removed, as prolonged efforts to save the pulp are nearly always followed by periodontitis of an intractable type. The following case is instructive: A patient, aged 12, fell and fractured a tooth, the maxillary right first incisor, and lacerated the pulp. The left first incisor was implicated by concussion. The pulp from the right first incisor was removed, and attempts made to save the pulp in the left tooth, which was irritable. The periodontitis around the right tooth rapidly cleared up, but continued with the left tooth. As the pulp condition failed to disappear at the end of three weeks, the canal was cleared of the morbid pulp, sterilized and filled. Chronic periodontitis continued in spite of repeated and various treatments for four years, so that removal of both teeth was decided upon. A radiogram of the teeth showed that the root of the tooth originally fractured had been attacked by rarefying periodontitis on the aspect adjacent to the left tooth, and the root of the latter had, to a great extent, disappeared from a similar periodontal condition. If the pulps of the teeth had been removed within a few days of the injury it is probable that the periodontitis would have passed away and the teeth would have been permanently saved.

(B) DISLOCATION

(1) Erupted Teeth.—By dislocation is understood accidental displacement of a tooth from its normal position in its socket. Dislocation may be either partial or complete, that is, the tooth may be forced into or loosened in the socket, or it may be totally displaced from its socket.

(*a*) **Causes.**—Dislocation, like concussion, is the result of violence, but the injury causing dislocation is usually of a more severe nature.

(*b*) **Treatment.**—*When the dislocation is partial*, the tooth should be replaced, the broken alveolar process moulded around it, and counter-irritants applied to the gum. With all dislocations, precautions should be taken to keep the tooth fixed, either by ligatures of silk or wire, or by a splint made of a suitable metal. *If the tooth is driven into the socket*, it should be grasped with a fine-bladed pair of forceps and carefully drawn into place. When a tooth is driven upwards towards the maxillary sinus, it is probably a safer plan to leave it alone rather than attempt its removal. If removal is considered advisable, care must be taken to prevent the complete displacement of the tooth into the maxillary sinus in the attempt at removal.

If the displacement is complete, the treatment will vary according to the age of the patient and the time at which the case is seen subsequent to the accident. In the young, if seen immediately after the accident (as, for example, when the tooth is displaced in the operating room), the tooth should be replaced at once, as under these conditions union of the structures entering at the apex may take place (see Diseases of the Pulp, p. 428). If the patient is an adult, or is seen some hours after the accident, the pulp of the injured tooth must be removed and the canals sterilized and filled before the tooth is replaced.

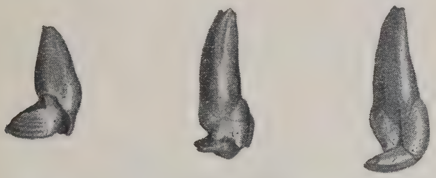

FIG. 449.—Maxillary first incisors showing the results of injury during development of the crowns.

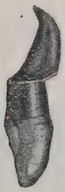

FIG. 450.—Maxillary second incisor showing the result of injury during the development of the root.

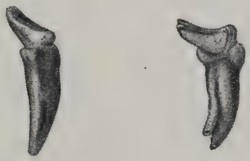

FIG. 451.—Mandibular incisors showing the results of injury during development of the crowns.

(2) Unerupted Teeth.—The permanent teeth may be injured in their crypts from traumatism, the portion of the tooth already calcified being partially separated from the portion which is developing. The condition is analogous to forcible separation of the epiphysis from the shaft in a growing bone.

The calcified portion of the tooth is usually dislocated in such a manner as to form an angle with the developing portion (see figs. 449 to 451. In the case of premolars the calcified portion

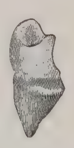

Fig. 452.—Maxillary first premolar.

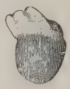

Fig. 453.—Mandibular premolar.

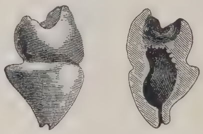

Fig. 454.—Mandibular premolar, from specimen in possession of G. G. Campion.

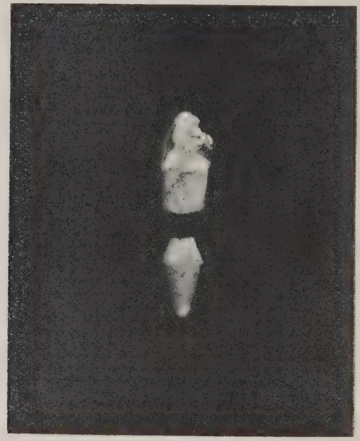

Fig. 455.

occasionally appears to be forced into the developing part, causing a kind of impacted dislocation (see figs. 452 to 454). It is possible that this condition is at times due to careless removal of the deciduous teeth. The injury to the growing tooth may result in an arrest of growth. Dislocation of unerupted teeth is more common in the anterior teeth, since they are more exposed to injury. Injury to the developing maxillary canine is rare owing to the position it occupies in the bone.

The injury may occur either to the crown or to the root, according to the state of development of the tooth at the time of injury.

When erupted, injured teeth often present a marked bulging at the neck, and marked mobility, and it is at times possible to trace the root through the alveolar wall. If a tooth can be felt high up in the alveolar wall and it fails to erupt injury to the tooth may be suspected.

A case was recorded by J. Lewin Payne[1] in which the mandibular right first premolar was in two pieces, as shown in fig. 455. The upper part of the lower fragment was cone-shaped and fitted accurately into the hollowed-out base of the upper fragment. The pulp cavity in the upper fragment was completely obliterated by "adventitious dentine," the pulp in the lower fragment being uncalcified. It seems possible that the condition of the tooth was the result of trauma.

(C) FRACTURE

Fractures of the teeth may vary from slight cracks or fissures of the enamel to extreme comminution of the whole tooth tissue.

They may be grouped as follows:—

- (α) Fractures of the crown.
  - (i) Without loss of tissue.
  - (ii) With loss of tissue.
    - (*a*) Not involving the pulp.
    - (*b*) Involving the pulp.
- (β) Fractures of the root.
- (γ) Fractures of both the crown and the root.
- (δ) Comminuted fractures.

(1) Causes.—The causes of fractures are generally direct or indirect violence, such as a blow from a cricket ball, a kick from a horse, blow on the chin, &c.

With advance in age increased calcification of the soft tissues of the teeth takes place, and this progressive change renders the teeth more brittle, and therefore more liable to fracture. This accounts for the fracture of teeth which occasionally occurs in elderly people during mastication. An example may be quoted. A man, sixty years of age, during mastication, fractured the maxillary left first premolar. He possessed the full complement of teeth, and there was no caries and very slight periodontal disease.

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[1] *Proc. Roy. Soc. Med.*, vol. v (Odonto. Sec.), p. 141.

The tooth was split in a mesio-distal direction through the fissure on the occlusal surface, the split continuing in a vertical direction upwards to the bifurcation of the roots. An examination of the tooth after extraction showed extreme translucency of the tissues, indicating considerable calcification of the soft tissue of the dentine.

Cases of fracture from the force of mastication are not always readily detected owing to the fragments being held tightly together by the surrounding structures. Under such conditions the pulp does not respond in an abnormal manner to thermal changes and is not tender on percussion, the only symptom being an acute pain at times during mastication.

(2) Treatment.

Group (a)—Without loss of tissue.—In these cases the enamel only is slightly cracked or fissured, and there is no loss of substance. No treatment is required.

With loss of tissue and not involving the pulp.—If the fracture involves only enamel, it will be necessary to smooth the rough edge or edges with suitable instruments and polish the surface. Should the dentine be exposed, it may be found hyper-sensitive, especially in young patients. There may also be hyperæmia of the pulp, characterized by extreme sensitiveness to heat and cold, and pain on pressure owing to the congestion extending to the periodontal membrane around the apex. The treatment is to employ counter-irritants or local depletion, at the same time to apply to the exposed dentine local remedies, such as absolute alcohol, nitrate of silver, or chloride of zinc. The symptoms usually subside and at a later period the tooth and its neighbour should be trimmed in such a way as to reduce the disfigurement as far as possible. Should suppuration occur in the pulp from continued irritation, the pulp cavity must be opened and treated in the usual way.

With loss of tissue and involving the pulp: Maxillary first incisor.—The treatment will depend upon—

(i) The stage of the development of the root.

(ii) The sex of the patient.

(iii) The presence or absence of a crowded condition of the teeth.

(i) *The Stage of the Development of the Root.*—The formation of the root of the first incisor is usually complete at about the age of ten years, and that of the second incisor at about the age of ten and a half years. A radiogram should be obtained if there is any doubt as to the stage of formation of the root.

If the formation of the root is incomplete the tooth should be removed. The question then to be decided is whether it is better to allow the space to close and to disregard the personal appearance, or to retain the space for purely æsthetic reasons, a denture with all its attendant disadvantages to the other teeth being inserted at a later period. When fractures occur after the completion of the root, the pulp should be removed and the canals treated; crowning can then be carried out at a future date.

(ii) *The Sex of the Patient.*—The loss of an incisor to a boy is of less æsthetic importance than to a girl.

(iii) *The Presence or Absence of Crowding of the Teeth.*—Where there is doubt whether to save or remove a fractured tooth, the condition of the teeth as regards crowding is an important consideration. If the teeth are crowded there is a reasonable probability that the space created by the loss of the tooth will close up completely, but, if there is no crowding, it is highly probable that the space will remain permanently. Each case must be treated on its merits. The following comments may be useful.

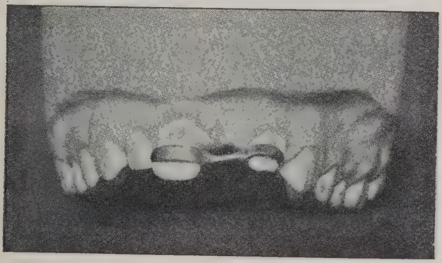

FIG. 456.

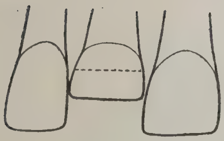

FIG. 457.

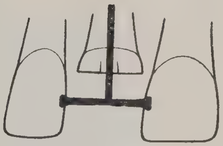

FIG. 458.

In *fracture of a maxillary first incisor in a boy before the root is fully formed*, removal of the tooth is to be recommended. In a boy the æsthetic question does not outweigh the advantages of avoiding a denture.

Fracture of a maxillary first incisor in a girl before the root is fully formed.—The tooth should be removed and the interval retained by an appliance attached to the approximal teeth (fig. 456). In constructing this appliance, care must be taken that the bands around the teeth are clear of the gingival margin. A denture should be inserted when the premolars and canines are in position.

In making dentures for this type of case, the best method is to attach the artificial tooth to a thin vulcanite plate which should cover the greater part of the roof of the mouth, thus avoiding all kinds of clasps.

The disadvantage of a small metal plate is that it is necessary to retain it by means of clasps, and as the clasps must be taken between the teeth the interproximal spaces are damaged.

Fracture of a maxillary first incisor after the completion of the root.—If the teeth are crowded, the better plan is to remove the fractured tooth. In the case of a boy the approximal teeth should be allowed to close together, but in the case of a girl the space should be retained. If the fracture is in the position shown in the diagram, fig. 457, the neighbouring teeth will not tend to approximate. If the fracture is near the region indicated by the dotted line, there will be a tendency for the neighbouring teeth to approximate. Steps must be taken to keep them apart by means of a stay fixed in the pulp chamber (fig. 458).

Maxillary Second Incisor.—Where the tooth is fractured before the root is fully formed extraction is advisable. In the case of a girl the appearance of the slightest crowding of the teeth on the opposite side of the mouth should be relieved in order to prevent as far as possible the centre of the mouth shifting (see p. 171). Fracture subsequent to the period at which the growth of the root is completed should be treated by removal of the pulp and the filling of the pulp canal. The tooth can be crowned at a suitable age.

In cases of fractured maxillary second incisors in crowded mouths, the removal of the tooth may be advisable. Judgment must be guided by the sex of the patient and the direction of the root of the canine.

Mandibular Incisor.—In almost every case removal is best. The space, even if it does not completely close, is not very noticeable.

Fracture of a canine, premolar, or molar should be treated by removal of the pulp and restoration of the tooth by suitable means.

Groups (β) *and* (γ).—Fractures of the root, or the crown and root, should be treated by extraction.

Group (δ).—Cases of comminuted fracture are generally caused by severe violence. Several teeth are usually involved, and the alveolar process is generally fractured. In these cases it is better to reflect the muco-periosteum from the surface of the bone and obtain a view of the area of fracture. The fragments of teeth and bone can then be removed and the muco-periosteum returned and secured in place by sutures.

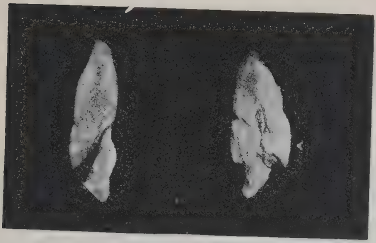

FIG. 459.[1]—The two outer surfaces of tooth from which the section (fig. 461) was removed.

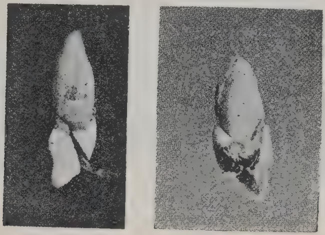

FIG. 460.[1]—The inner surfaces of the preceding figure (fig. 459).

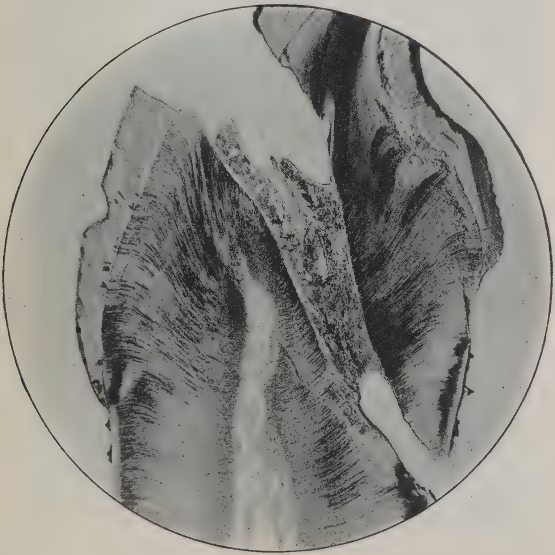

FIG. 461.—From a photomicrograph lent by F. J. Bennett.

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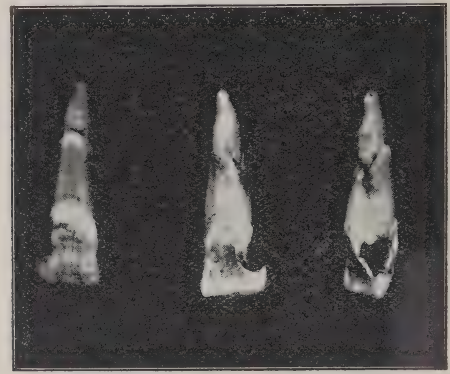
[1] From *Trans. Odonto. Soc.*

(3) Healing of Fractured Teeth.—Union of fractured teeth may take place and a few cases have been recorded. The union is similar in character to that which takes place in bone. In a case quoted by Wedl, and shown in his "Atlas of Pathology,"[1] union was effected by means of the periodontal membrane and the pulp.



Anterior Posterior surfaces. Distal

FIG. 462.[2]

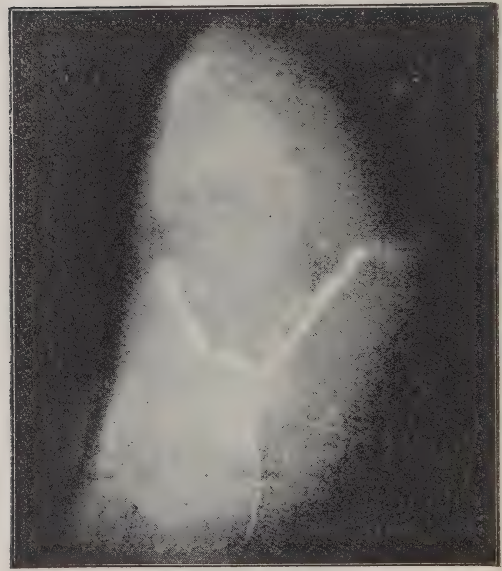


FIG. 463.[2]—Showing groove on surface of root.

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[1] "Atlas to the Pathology of the Teeth" (Second Edition), 1893, figs. 107 to 109.

[2] From *Dental Record.*

A rare example of union of a fractured tooth was recorded by Storer Bennett.[1] A maxillary incisor had been fractured across the crown. The patient was 17 years of age, and ten months previously had fallen down, struck the tooth and dislocated it upwards, when it became impacted and remained until removed owing to pain. The tooth is shown in figs. 459 and 460. The bond of union is of a cavernous character with numerous spaces for blood-vessels (see fig. 461).

Fractured roots are more likely to unite when the fracture is near the apex, because the fragments are kept in fairly accurate apposition by the socket of the tooth. An excellent example is recorded by G. W. Watson.[2] The maxillary right first incisor of a man, aged 24, was loosened by a blow from a cricket ball. The tooth remained loose and painful for a month after the injury and was slightly misplaced inwards, but eventually became firm and serviceable again. About six years later the tooth was removed, and it was then seen that the blow had fractured the root and repair had followed. The appearance of the tooth was as follows: "About a quarter of an inch from the apex of the root on its labial surface there was a deep, somewhat irregular crescentic groove, continued halfway round the median and distal surfaces. Radiating from these two points and extending round the lingual surface of the tooth was a series of comminuted fractures running in all directions." Illustrations of the tooth are shown in figs. 462 and 463.

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[1] *Trans. Odonto. Soc.*, vol. xxviii, p. 181.

[2] *Dental Record*, May, 1906, p. 216.

CHAPTER XI

Caries of the Teeth

Prevalence of Caries—Frequency in Individual Teeth—Morbid Anatomy and Pathology—Spontaneous Arrest of Caries—Experimental Reproduction of Caries—Susceptibility and Immunity to Caries—Etiology—Symptoms

The teeth of man have been affected by caries from the earliest times. The Rhodesian skull, belonging to a race which existed long before the present type of human beings was evolved, shows definite caries of many teeth.

(A) PREVALENCE OF CARIES

(1) Ancient Races

J. R. Mummery[1] examined skulls from "the ancient British tumuli of Wiltshire." In sixty-eight skulls (dolichocephalic type) from the long-shaped barrows, which date back to the *Stone Age*, only two cases of caries were discovered, one on an approximal surface and one on an occluding surface. These people were a pastoral and not an agricultural race. They lived by the chase and their customs were barbarous.

In thirty-two skulls (brachycephalic type) from the round-shaped barrows (*Bronze Period*), there were seven cases of caries, six on approximal, and one on occluding surfaces. These people probably consumed mostly vegetables in the form of coarsely prepared barley or oats. (This race was referred to by Cæsar in his "Commentaries.")

In sixty skulls from the Yorkshire barrows, consisting principally of the earlier or long-headed race, twenty-four exhibited caries, and in nine cases the disease was extensive. In some cases the incisors were affected. Nearly half these skulls showed extensive attrition of the teeth, and there were thirteen examples of dento-alveolar abscess.

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[1] *Trans. Odonto. Soc.*, vol. ii, N.S. Over 3,000 skulls were examined, and of these, 1,658 were tabulated, the remainder being rejected either in consequence of their doubtful authenticity, or because too many teeth were missing. This work of J. R. Mummery entailed a vast amount of labour, and is one of the most valuable contributions to the dental literature of the sixties.

The skulls of *Romans* found in England also furnish ample evidence of caries. In 143 skulls caries was present in forty-one cases; in nineteen skulls more than six teeth were affected and in twenty-nine skulls caries was present on approximal surfaces. In some cases all the teeth were affected, including the incisors. The diet included meat, fish, wheat and miscellaneous luxuries. It is of interest to note that twenty-three of the skulls were found in Yorkshire, and of these eighteen exhibited caries.

Passing to the *Anglo-Saxon* period, we find that out of seventy-six skulls caries was present in twelve; in five instances the approximal surfaces were attacked.

Egyptian mummies to the number of thirty-six were examined; fifteen showed caries—in nine cases all the premolars and molars were affected and in two cases all the maxillary incisors.

J. G. Turner examined 104 Egyptian skulls belonging to the period of the twenty-fifth to the thirtieth dynasties; 40·38 per cent. showed caries, and, of 435 loose teeth, 16·6 per cent. were affected.

The foregoing statistics show that races like the Romans and Egyptians, which had reached a high standard of civilization, were more susceptible to caries than races living under more primitive conditions.

(2) Existing Primitive Races

In an examination of existing primitive races, Mummery found evidence of caries in all of those of which statistics are given.

The following is a résumé of the section of Mummery's paper dealing with existing primitive races[1]:—

Esquimaux.—A nomadic people inhabiting the littoral in the extreme north. Diet: Almost entirely meat, fowl and fish, of which huge quantities—10 to 14 lb. per person—are consumed daily. Only one case of caries in sixty-nine skulls. In another instance two molars were missing.

Indians of North-West Coast of America.—Diet: Chiefly dried fish. Two cases of caries in fifty-one skulls. The approximal surfaces of two teeth were attacked. The fish is coarsely prepared for food and quantities of sand adhere to it. The teeth show considerable attrition.

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[1] The term "extensive" is used for skulls showing over six carious teeth.

North-American Indians (interior).—Often subject to great privations. Diet: Meat with occasional addition of roots. Two cases of two carious teeth in twenty-one skulls.

Gauchos.—Mixed race of Indian and Spanish blood in the Argentine Republic, occupied on ranches and living mostly on horseback. Diet: Entirely "roast beef"; sole beverage, Paraguay tea without sugar. No record as to caries is given, and only one case of toothache was discovered.

Indians of the same race, inhabiting towns and indulging very freely in artificial diet, such as acid confectionery, and inferior wines. Caries prevalent.

Fiji Islanders.—Addicted to cannibalism. Diet: Meat, fish, maize, bread-fruit, plantain, cocoa-nut. Two cases of caries in thirty-eight skulls; in one, two teeth were affected, and in the other, caries was extensive.

Maori.—Addicted to cannibalism. Diet: Meat, fish, fruit and vegetables. According to Pickerill, their staple food was the kumara or sweet potato. Two cases of caries in sixty-six skulls; in one of which two teeth and, in the other, four teeth were affected on the approximal surfaces.

In 260 skulls of the uncivilized period, examined by Pickerill, two cases of caries; but out of fifty children living under European conditions 95 per cent. showed caries.

Inhabitants of Eastern Polynesia.—Diet: Pork, fish, cocoa-nut, plantain, bread-fruit and sugar-cane. Eight cases of caries in seventy-nine skulls, most of them extensive, and in one case the approximal surfaces were affected.

Sandwich Islanders.—Diet: Mainly vegetable with a little meat; staple food a root called "taro," roasted and eaten as a substitute for bread, to which sweet potato and sugar are occasionally added. Four cases of caries in twenty-one skulls, two being extensive; in three cases the approximal surfaces were affected.

Australian Races.—"For the most part improvident savages, and spending their lives in alternate feasting and famine." Diet: Mainly meat, fowl, fish, and in times of scarcity lizards, ants, frogs and wild roots. Caries in twenty-seven skulls out of 132, the approximal surfaces being affected in fifteen cases.

Tasmanian Race.—Closely resembling the Australian races in habits and diet. Caries in nine skulls out of thirty-three, mostly affecting a considerable number of teeth, and in eight cases affecting the approximal surfaces.

Zulu Kaffirs.—Staple food: Coarse-ground mealies, meat being consumed on special occasions, as in the training of their warriors.

Caries in six skulls out of forty-nine; five of very limited extent, one case of approximal caries.

African Tribes supplying the Slave Markets.—The most feeble of the African tribes; mainly in unhealthy districts. Diet: Mixed, chiefly vegetables. The skulls of 268 slaves who had died of disease or exhaustion were examined. In sixty-six caries was present, many of the cavities being on approximal surfaces. In no less than sixteen of the cases the whole of the molars and premolars were carious.

The Bushmen.—Dwarfs inhabiting the deserts of South Africa. Diet: Chiefly meat, but in times of scarcity edible roots, locusts, &c. In twenty-nine skulls six cases of caries were found, the majority being extensive. In three cases the approximal surfaces were affected.

The Natives of Southern India.—Diet of a varied character, frequently of an unwholesome nature. Rice forms the staple food; sweetmeats are much indulged in. In seventy-one skulls ten cases of caries, in three of which six teeth were involved. Four cases of approximal caries.

The Natives of Northern India.—Diet: Vegetables of a simple and wholesome character, staple food being wheat. In 152 skulls nine cases of caries, and in no instance more than two teeth affected. One case of approximal caries.

Malays.—Diet: Mixed; fruit, birds and fish. In twenty-four skulls three were affected, and in one of these there was extensive caries.

Chinese.—Staple food, rice. In ten skulls out of twenty-seven caries was present, and in six the disease was extensive.

Mummery's results in tabulated form are as follows:—

	Skulls examined	Percentage of skulls showing carious teeth	Skulls showing destructive attrition
Esquimaux	69	1·4	22
Indians N.W. Coast North America	56	3 9	32
Indians interior N. America	23	9·5	2
Fiji	38	5·2	4
Maoris (New Zealand) ...	67	3·0	25
Eastern Polynesia ...	79	11·4	15
Sandwich Islanders ...	21	19·0	4
Australian Races... ...	132	20·4	28
Tasmanian Race	33	27·2	6
Kaffirs (Zulu)	49	14·2	6
African Slaves	236	20·8	23
Bushmen	29	20·6	9
Southern Indian Races ...	71	14·0	10
Northern Indian Races ...	152	9·5	8
Malay Races	24	12·2	2
Chinese...	27	37·0	0

Mummery's figures show that races whose principal diet is flesh are more free from caries than those existing wholly or mainly on a vegetable diet. Exception has been taken by certain writers to the dietaries set forth by Mummery. In this connection it is to be noted that the present-day diets of primitive races are not necessarily the same as those of some years ago. For example, the Barotze (N.W. Rhodesia) within the last seventy years have added cassava (a root from which our tapioca is made) to their staple food-stuffs.

S. Colyer has published statistics relating to certain *African Tribes of Bantu descent*:—

Central African tribes from the region of Lakes Mweru and Bangweulu.[1]—The figures were provided by 1,000 natives (males) examined consecutively. The natives came from three districts, which will be referred to as I, II, III. Districts I and II were "saltless," District III "a great salt producer." The natives were divided into three classes according to age:—

Decade 2, ten to twenty years.
,, 3, twenty to thirty years.
,, 4½, thirty to forty-five years.

The division must be regarded as approximate, the ages having to be guessed.

Many of the natives file the front teeth and expose the dentine which in many cases shows caries. These teeth are not included in the following figures because the object of the examination was to discover the incidence of true caries of the enamel. The following table shows the percentage of caries in the different age periods:—

	Decades			
	2	3	4½	Total
Number of individuals examined	246	670	84	1000
Percentage with caries	5·7	9·8	21·4	9·8
Percentage without caries	94·3	90·2	78·6	90·2
Percentage of carious teeth per individual ...	·3	·7	2·1	·73
Percentage of teeth per individual lost from other causes	·1	·3	3·7	·58

Note.—All teeth the loss of which was probably due to caries are included as carious teeth. The number of teeth per individual is taken as twenty-eight.

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[1] *Dental Record*, vol. xxxvii, p. 407.

The incidence according to districts is shown in the following table:—

District	Number of individuals	Percentage with caries	Percentage of carious teeth	Percentage of teeth lost from other causes
I	185	8·1	·36	·42
II	700	11·1	·91	·67
III	115	5·2	·24	·21

Note.—District III is the salt-producing area for the surrounding country.

The diet of these natives is mainly millet porridge, to which is added in the rainy season maize, pumpkins, beans and potatoes.

South-East African Tribes in the Transkeian territories.[1]—These natives, of Bantu descent, have caries similar to that of highly civilized man, that is, interstitial and fissure cavities. Natives may be seen with " every tooth save, perhaps, a few isolated ones in their jaws, decayed and level with their gums." Caries of the incisors is comparatively common.

The staple foods are mealies and Kaffir corn; sugar is consumed in large quantities, taken with porridge; used to flavour tea and coffee, and eaten raw. One family of six members consumed six pounds of sugar each week.

In investigations on caries, it is important that the position of the cavities should be given and a distinction made between caries starting in the enamel and in the cement.

The following figures given by J. G. Turner relative to *South Sea Islanders* show the high degree of cervical caries in some of the primitive races. Their diet is fruit, vegetables and cocoa-nut coarsely prepared. Turner found caries in 28·88 per cent. of ninety skulls and 8·24 per cent. of 1,116 teeth. There were thirty-five interstitial-cervical, twelve lingual-cervical, and twenty-four buccal-cervical cavities. Ninety teeth had been lost ante mortem.

An interesting report on the examination of old human crania deposited in the principal museums of the United States is published in the *Transactions of the American Dental Association*, 1894, and is well worthy of perusal by those wishing to investigate the subject. The following is a résumé of the results obtained:—

Total number of teeth examined	46,657
Total number of teeth diseased	11,338
Percentage of diseased teeth	24·3

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[1] *Dental Record*, vol. xxxix, p. 401.

The crania were grouped geographically as follows:—

	Number of teeth examined	Number of carious teeth	Percentage of carious teeth
South America	6,719	930	5·8
Central America	930	44	4·87
North America	27,362	1,394	5·09
Europe (including Anglo-Americans)	3,422	242	7·07
Pacific & Sandwich Islands	2,738	118	4·3
Egypt (including Africans)	3,306	113	3·41
Asia	2,180	45	·06

(3) Modern Civilized Races

Among modern civilized races the percentage of mouths containing carious teeth has increased very considerably.

Londoners of the Seventeenth and Eighteenth Centuries.—The following facts obtained from an examination of a series of skulls and mandibles belonging to the seventeenth and eighteenth centuries afford some evidence of the condition of the teeth of Londoners of that period:—

	Specimens examined	Number with full dentures
(1) **Skulls with mandibles**	38	10
(2) **Skulls only**	128	48
(3) **Mandibles only**	227	103

In the specimens 3,349 teeth were present, 345 being carious, or 9·8 per cent. Dividing the specimens into two groups—

(A) Those in which no teeth had been lost from disease,

(B) Those showing loss of teeth from disease,

we find that in group A 1,449 teeth were present, of which fifty-nine were carious, or just over 4·07 per cent.; in group B, 1,900 with 286 teeth carious, or about 15 per cent.

The post-mortem loss of so many teeth, especially incisors, canines and premolars, in old skulls makes it very difficult to arrive at a reliable estimate of the amount of caries, so that data obtained from the molars, and especially the first molars, give a truer picture of the amount of caries in these teeth. Of 1,456 first, second and third molars, 212 were carious, or 14·5 per cent. Of 581 first molars, 105 were carious, or 18 per cent.

In order to obtain a more accurate estimate of the probable number of teeth which had been attacked by caries it is necessary to:—

(1) Include as carious teeth a proportion of those lost ante mortem. Half the teeth were considered to have been lost from caries, the other half from periodontal disease.

(2) Estimate the number of carious teeth among those lost post mortem.

Working on these lines it was estimated that of the 6,804 teeth, approximately 14·6 per cent., and of 862 first molars, 27·6 per cent., had been attacked by caries. An examination of the series of thirty-eight skulls with mandibles showed:—

Number of skulls and mandibles	Number of carious teeth
12	0
11	1
4	2
2	3
2	5
3	6
1	9
1	11
1	13
1	17

In other words, fifty out of the 103 carious teeth were present in four specimens.

The collective investigations of the British Dental Association showed that in the mouths of 10,500 English and Scotch girls and boys, averaging 12 years of age, there were no less than 37,000 unsound teeth (deciduous and permanent). In all, 86 per cent. of the mouths showed that caries was present in one form or another.

The subjoined table[1] shows the relative ratio per hundred of children with unsound teeth, defective deciduous teeth, and defective permanent teeth. The figures afford an illustration of the early age at which the decay begins, and also of the progressive increase of the disease as children grow older.

Age period	iv.-vi.	vii.-ix.	x.-xii.	xiii.-xv.	xvi.-xviii.
Number examined	744	1,716	3,071	2,376	268
Sound (no decay)	23·8	14·2	16·1	14·1	6·4
Defective deciduous teeth only	67·4	43·3	18·3	5·1	0·1
Defective permanent teeth—					
1—4	8·8	41·5	55·9	51·9	37·3
5—8	—	1·9	8·5	22·9	32·6
9 or more	—	—	1·2	6·0	23·6

Another illustration of the ravages of caries can be gathered from the statistics compiled from the examination of the children in the County of Shropshire.[2] It was found:—

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[1] Memorandum in regard to the condition of the teeth of school children, published by the British Dental Association, p. 64, showing the relative ratio per hundred children having unsound teeth, defective deciduous teeth, and defective permanent teeth.

[2] The Seventh Annual Report of the School Medical Officer of the Salop County Council, 1914.

(i) That only 3 per cent. of the children at the age of twelve and only 5 per cent. at the age of five were free from caries.

(ii) That the average number of carious teeth at the age of five was 6·8 and at the age of twelve was 4·8.

(iii) That out of 3,794 children examined at the age of five, no less than 1,017 had ten or more carious teeth; and out of 3,580 children at the age of twelve, 876 had seven or more carious teeth.

The foregoing figures relate to children attending the Poor Law schools, workhouses, and reformatories. Equally unsatisfactory conditions have been shown to exist among children in better circumstances; for example, 560 boys, average age 13 years 7 months, belonging to one of our large public schools, had lost 701 of the permanent teeth, while 3,521 were carious. In the mouths of 87 per cent. of the boys caries was present. In America, Germany, Hungary, and other countries, similar investigations have yielded much the same results. The investigations of Unghvari (Hungary) and Berten (Würzberg) show the percentages of carious teeth to be 87·2 and 83; while Röse, in an extended inquiry in Baden and Thuringia, and Fenchel (Hamburg) showed caries present in 98·75 per cent. and 96·4 per cent., respectively. The statistics of Röse and Fenchel indicate that, as regards caries, the teeth of English children compare favourably with those of German children.[1]

The rapid increase in caries between the ages of six and thirteen years is well shown in the diagram, fig. 464, prepared by F. W. Richards.

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[1] The following communications on this subject are of interest:—

The various reports of the School Children's Committee appointed by the British Dental Association.

Voerckel and Weber. "On the Care of the Teeth of Children in the National Schools of Elberfeld and Witten," *Deutsche Monatsschrift für Zahnheilkunde,* translated in Ash's *Quarterly Circular,* December, 1899, and March, 1900.

Röse. "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde,* translated in Ash's *Quarterly Circular,* March and June, 1895.

Unghvari. *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde,* translated in Ash's *Quarterly Circular,* September, 1896, p. 353.

Berten. *Aus den Sitzungsberichten der Würzburger physik. med. Gesellschaft,* 1894, xv, Sitzung November 17.

Fenchel. "Die Caries Frequenz Hamburger Schulkinder," *Correspondenz-Blatt für Zahnärzte,* October, 1893.

Ottofy. Addendum in Parreidt's "Compendium of Dentistry," Chicago, 1889, p. 57.

Cunningham, C. M. "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.,* vol. xviii, p. 652.

The foregoing figures will suffice to illustrate the appalling ravages of dental caries among modern races. It is satisfactory to know that other investigations have brought forth results which show more hopeful conditions. For example, C. M. Cunningham[1] found that among fifty-four children in the Arran Islands there were thirty-three perfect dentures, and clinical experience undoubtedly shows that the number of perfect dentures is increasing among the children of the more intelligent sections of the community.

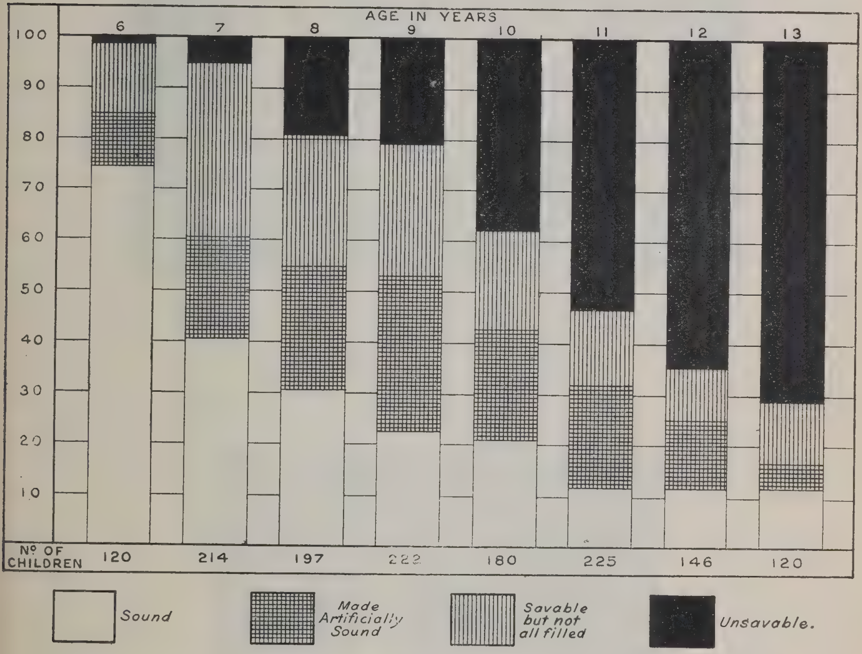

FIG. 464.—Diagram showing the relative liability to caries according to age. From *Brit. Dent. Journ.*, vol. xxx, p. 572.

Recent reports of school dentists indicate, too, a welcome decline in dental caries. T. A. Edmondson found that out of 2,403 children inspected in 1920, 15·7 per cent. had sound dentures in contrast to 10·8 per cent. in 1919.

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[1] "An Examination of Teeth in the Arran Islands, co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xviii, p. 652.

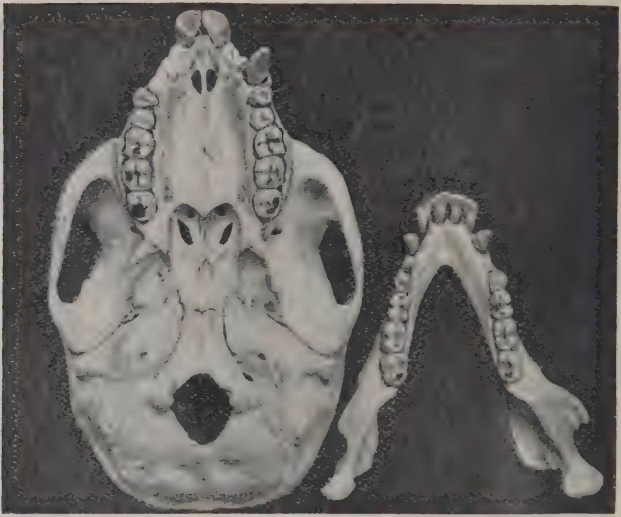

Fig. 465.—Skull and mandible of a monkey (captive animal) with caries of the teeth.

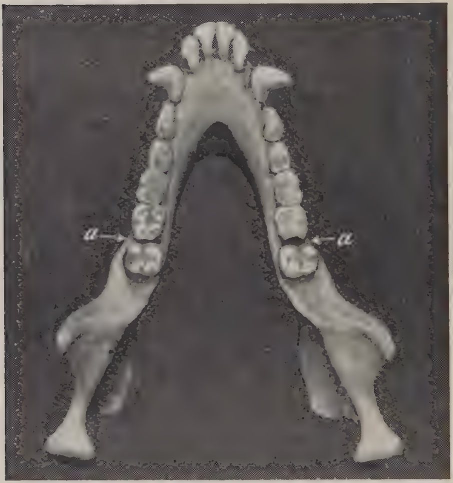

Fig. 466.—Mandible of a monkey. The third molars are rotated, the external surfaces looking forward; this irregularity has caused " catchment " areas between the grooves on the external aspects of the third molars and the distal aspects of the second molars. The distal aspects (*a*) of the second molars are carious.

Caries in Animals.—(*a*) Wild Animals. In reviewing the liability of wild animals to caries, it is necessary to discriminate between animals living under natural conditions and those in a state of captivity. In the wild state, apes and monkeys alone show caries, while, in captive animals, the disease occurs in apes, monkeys, bears, kangaroos and rodents.

The skulls of monkeys in the British Museum are with few exceptions those of animals from the wild state. Out of 851 skulls of Old World monkeys twenty-four showed caries, or about 2·8 per cent. Out of 609 skulls of New World monkeys fifteen showed caries, or about 2·4 per cent. In the Old World group, the genera Cercopithecus and Macacus are most liable to caries; in the New World group the genus Cebus. Animals from certain districts show a high degree of caries, for example:—

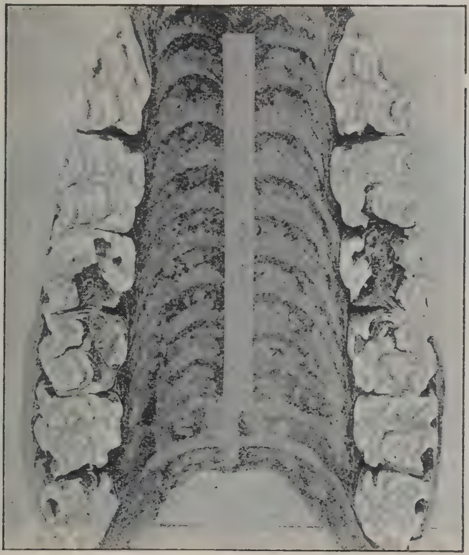

FIG. 467.[1]—Maxillæ of a horse showing extensive caries of the teeth.

Of four specimens of *Cercopithecus whitesidii* from Bompana (Congo), two showed caries.

Of four specimens of *Cercopithecus pygerythrus* from Coguno two showed caries.

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[1] From *Trans. Odonto. Soc.*

Of ten specimens of *Cebus azaræ* from Matto Grosso, Brazil, four showed caries.

In captivity the monkeys show a greater liability to the disease. In 254 specimens of Old World monkeys from collections mainly composed of skulls of captive animals, there were twenty-six cases of caries, or 10·2 per cent.

(*b*) *Domesticated Animals.*—In the horse, caries is by no means a rare disease, and in an examination of 484 skulls caries was found in sixty-six.[1] In some cases the condition was slight, whilst in others extensive destruction of the teeth had occurred (see fig. 467). Owing to the arrangement of the dental tissues, the carious tissue is removed in a great measure in the process of mastication, so that more or less cup-shaped depressions, lined with a thin layer of softened tooth tissue, are formed.

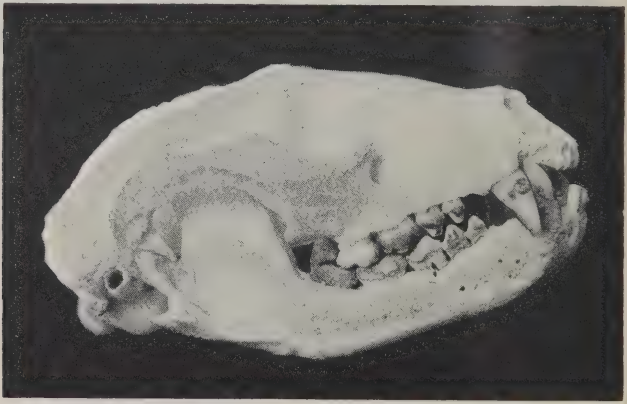

Fig. 468.—Skull of a dog showing caries on the labial aspects of the teeth.

Hutch-fed rabbits would seem to be liable to caries. In eleven skulls of animals kept by L. Guanziroli, six showed some degree of caries. These animals were fed on a plentiful supply of middlings in addition to the ordinary green food-stuff. Caries is also met with in the dog, fig. 468.

(B) FREQUENCY IN INDIVIDUAL TEETH

The various groups of teeth in human beings are subject to caries in different degrees. The statistics bearing on this question are nearly all derived from records of extractions and it is needless to say that statistics so obtained will not correctly represent the relative tendency to caries in the different groups. The first permanent molars are more subject to caries than other teeth, and the mandibular more than the maxillary. The first permanent molars are erupted early and the liability to caries is due to the unhygienic conditions in the mouth at this period rather than to any inherent structural defect. The caries nearly always commences on the occluding surfaces. These teeth are probably less liable to decay on the approximal surfaces than the maxillary premolars. The second molars probably follow next to the first molars in their liability to caries, the mandibular being attacked more frequently than the maxillary. It is extremely difficult, without trustworthy statistics, to place the incisors and premolars correctly as regards their liability to caries. Experience affords little evidence on which to choose between the first and second maxillary premolars in this respect, but with regard to the mandibular premolars the liability to caries is more marked in the second than in the first. The mandibular incisors are comparatively immune to caries, and this is due as much to their shape as to the constant mechanical cleansing action of the tongue and lips. The liability of the third molars to caries in mouths where all the teeth are present is attributable to difficulty in keeping them free from the lodgment of food débris.

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[1] "Variations and Diseases of the Teeth of Horses," J. F. Colyer, *Trans. Odonto. Soc.*, vol. xxxviii, p. 42.

Frequency in Relation to Sex and Age.—It is generally supposed that caries is more common in females than in males. The observation of Röse[1] on 6,280 children, boys and girls being about equally divided, showed the percentage of caries in boys to be 26 and girls 26·2. Caries is more active during the period of growth of the individual than subsequently. A fresh period of activity often appears with conditions which lead to exposure of the roots of the teeth, the caries commencing in the cement.

(C) MORBID ANATOMY AND PATHOLOGY

(1) MACROSCOPICAL APPEARANCES

(*a*) **Enamel.**—In the enamel, the naked-eye appearances of caries can best be observed upon the approximal side of a molar or premolar. The first indication of the presence of caries is that the enamel loses its normal polish and translucency. Next, a whitish spot appears which gradually becomes darker. When the process is slow, the discoloration is more marked than when the process is rapid. As the enamel prisms become disorganized, they are mechanically washed away and a cavity is left which varies somewhat in form, being sometimes broad and shallow with indistinguishable margins, at other times deep with sharp, rugged margins. The destruction advances until the dentine is reached.

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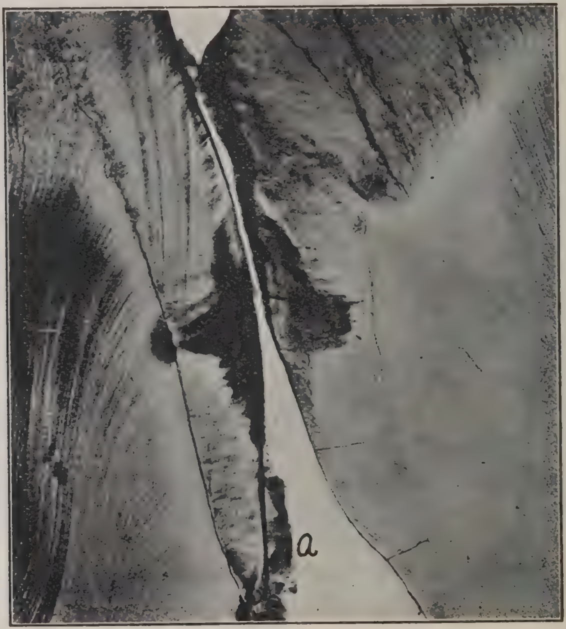
[1] Röse: "On the Decay of Teeth in the National Schools of Germany," *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde,* translated in Ash's *Quarterly Circular,* March and June, 1895.

At times decalcification may have attacked the dentine before any disintegration of the enamel has occurred (see fig. 469).



× 35.

FIG. 469.[1]—Decalcification of the enamel without loss of substance (Miller).

When caries commences on the approximal aspects of the teeth, the actual point of contact is not always decalcified, but around it is a zone showing decalcification. This zone corresponds to the area on the tooth where fluid would be held by capillary attraction.

When the decay which has started on the approximal surface reaches the under surface of the enamel of the crown (as is frequently the case in molars and premolars), the enamel at that part appears bluish-white and translucent, especially by artificial light. This appearance is produced by the decalcified tissue which has not been removed by the saliva. As the caries reaches the surface, the enamel grows whiter, and eventually becomes so thin that mastication fractures it, and the under surface is found to be of a soft, cheesy consistency. Caries commencing on the dentinal aspect of the enamel and proceeding to the surface is known as "secondary enamel decay" (figs. 470 and 471).

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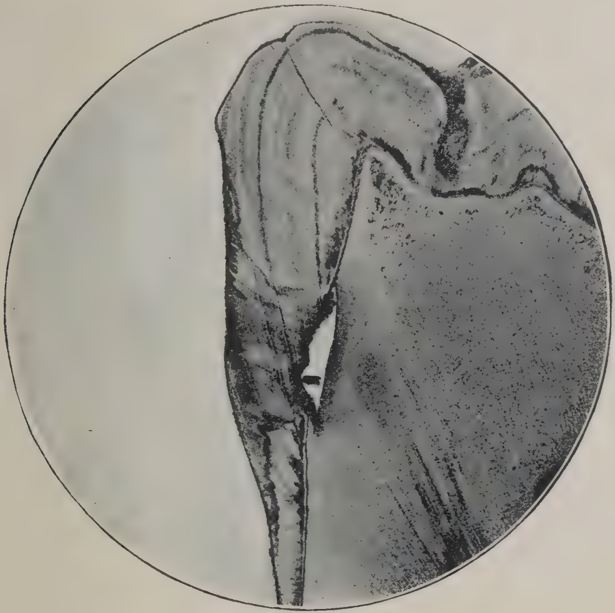
[1] From *Dental Cosmos*.



× 35.

Fig. 470.[1]—Primary and secondary caries of enamel, showing marked difference in their character (Miller).

In children in whom rickets develops towards the end of the first year and after the eruption of the incisors, these teeth are often completely decalcified, brown, leathery masses being left, with the original contour of the teeth preserved. There is no proteolytic dissolution of the colloidal substance. In these children the saliva is quite acid.

(*b*) **Dentine.**—The appearances of caries in dentine differ considerably from those in enamel. The dentine becomes of a tough, cartilaginous consistence, and not soft and cheesy as with the enamel. After softening, the tissue undergoes disintegration, and a cavity is formed. Pigmentation accompanies the process and, as in caries of the enamel, the discoloration depends to a great extent upon the rate of progress of the disease.

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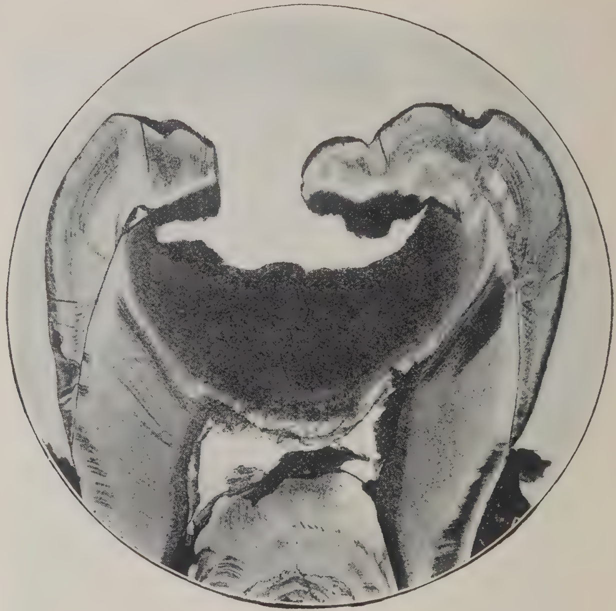
[1] From *Dental Cosmos*.

Caries may spread in any direction and with varying degrees of rapidity. The rapidity of its progress depends upon the intensity of action of the various ferments. The direction taken is largely determined by the structure of the tooth. In a tooth of ordinary structure the cavity formed is somewhat cone-shaped, the apex of the cone being towards the pulp. In badly developed teeth with a large number of interglobular spaces, the decay will extend laterally and considerably undermine the enamel, whilst in teeth where the dentine is well calcified the decay will extend more in the direction of the pulp than laterally, giving rise to what is known as "penetrating caries."



× 10.

FIG. 471.[1]—Secondary caries of enamel. The acid destroys the enamel as it advances. Apparent increased transparency of the enamel (Miller).

In hypoplastic teeth the caries often extends rapidly near the junction of the enamel with the dentine and causes the enamel to break away, producing an appearance as illustrated in fig. 472.

---

[1] From *Dental Cosmos*.

In "rapid caries" the dentine can be removed in large leathery masses, the action of the acid being more rapid than that of the peptonizing organisms. This condition is called **"caries humida."** When the carious process is slow, the action of the peptonizing organisms almost keeps pace with the action of the acids.

(*c*) **Cement.**—Caries of the cement is less common than caries of the dentine or of the enamel. It generally starts at the neck of the tooth, though it may attack any part of the root when the roots are exposed through loss of the periodontal membrane. The cemental tissue first becomes softened, and disintegration follows, leading to the formation of shallow cavities. The cavities become widely extended, but owing to there being no circumscribed points of retention, they are seldom deep. An exception, however, occurs at the angle formed by two roots of a molar, the cavity at this point often becoming deep.

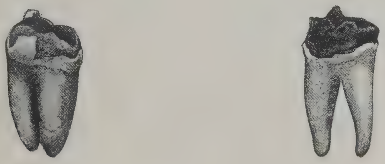


FIG. 472

(*d*) **Nasmyth's Membrane.**—The naked-eye appearance of destruction of Nasmyth's membrane is a more or less pronounced discoloration.

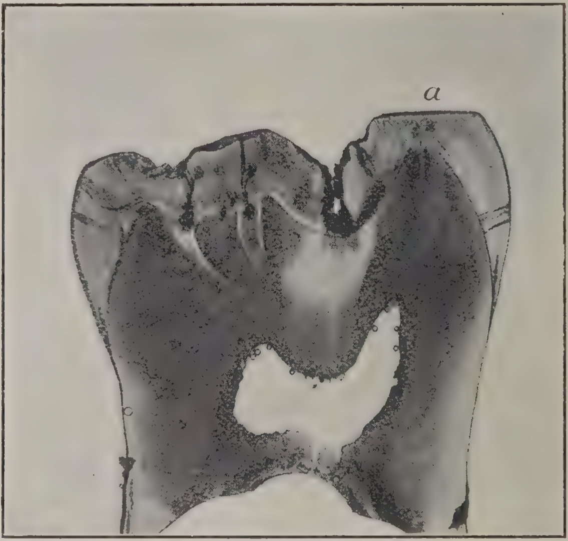
(*e*) **Phenomena accompanying caries:**—

(i) *Translucency.*—If the dentine of a tooth in which caries is in progress be examined, it will be found that in the part situated between the pulp and the caries the tissue appears translucent (fig. 473). The translucent zone is best observed in those teeth in which the enamel only is attacked and the dentine is perfectly sound. The affected area assumes the shape of a cone with its apex towards the pulp and on either side of this area two opaque lines will usually be seen.

There is a difference of opinion as to the cause of this translucency. The opacity of normal dentine is due to the fact that the matrix and the contents of the tubes have different refractive indices. If these indices are approximated the dentine becomes translucent. The difference in the refractive indices would be removed (*a*) if the matrix were transformed so as to resemble the contents of the tubes, i.e., by *decalcification of the matrix;* (*b*) if the tubes became filled with materials resembling the matrix, i.e., by *calcification of the tube contents.*

The following facts support the view that the translucency is due to a change in the contents of the tubes:—

(*a*) Injury of the dentinal fibrils causes reaction in the pulp, leading to the formation of secondary dentine at the point corresponding to the commencement of such fibrils on the surface of the pulp.



× 10.

FIG. 473.[1]—Section of molar showing typical translucent zone in the dentine (Miller).

(*b*) The diameter of the tubes, according to Walkhoff and Baume, is distinctly lessened in the translucent zone.

(*c*) Chemical analyses of the dentine forming the translucent zone have been carried out by Miller and Jeserich. The former found 71·9 per cent. ash from translucent zone dentine and 72·1 per cent. from the normal dentine of the same teeth, a difference which is quite likely to be due to an error of experiment. Jeserich's results gave 68 per cent. for the normal and 69·5 per cent. for the translucent dentine. The experiments, therefore, do not point to decalcification as the cause of translucency.

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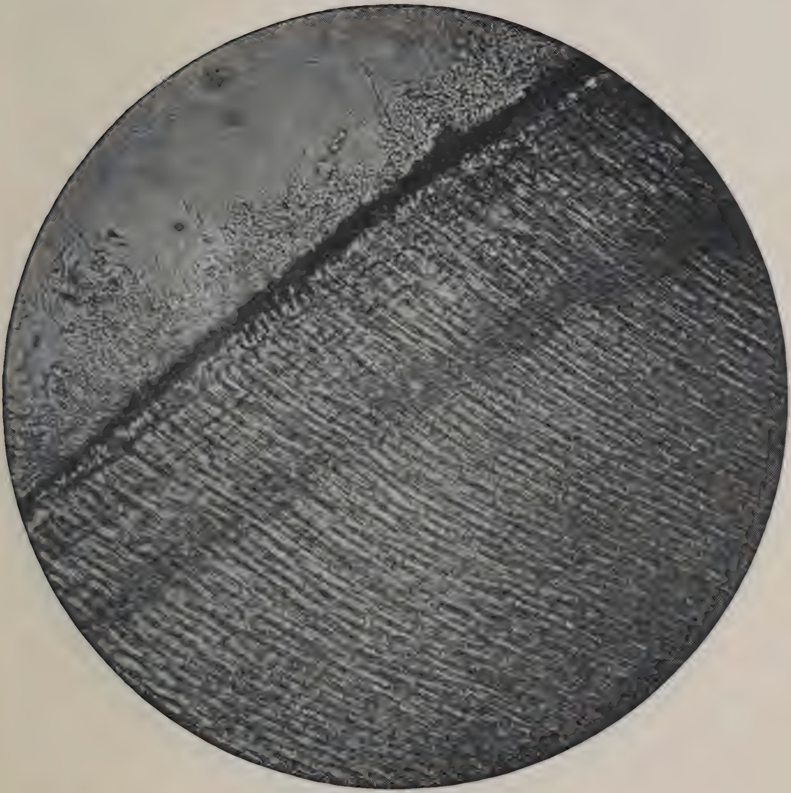
[1] From *Dental Cosmos.*

(*d*) Stains do not readily affect the translucent zone. Partially decalcified dentine is readily stained with eosin, but the stain has little effect on the translucent zone.

(*e*) Charters White has found that in specimens in which the dentinal tubes are permeated with coloured collodion, the tubes in the translucent zone are only slightly permeable.



× 300.

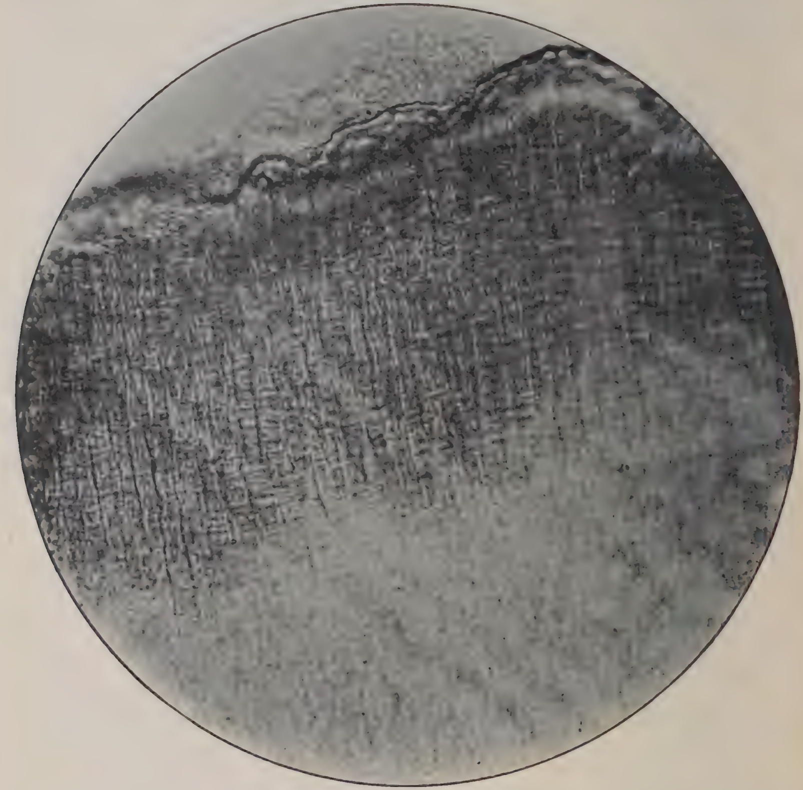
FIG. 474.—Section showing felt-like mass of micro-organisms attached to surface of enamel. Photomicrograph by Leon Williams.

(*f*) In teeth in which alcoholic fuchsin is allowed to penetrate the dentine by capillary attraction from the pulp cavity, the stain does not penetrate the tubes in the translucent zone when this is well developed.

(*g*) If the translucent zone were the result of decalcification we should expect to find it in all sides of the carious cavity, but this is not the case, the only portion of the dentine affected being that containing fibrils which have been injured by the carious process.

(*h*) In artificial caries there is no translucent zone.

(*i*) In caries progressing in pulpless teeth there is no translucent zone. Miller examined sixty teeth which had been worn in the mouth on plates. Most of the teeth showed various stages of decay, but translucency was only present in one, and even in that one it was impossible to say that the translucency had not originated when the pulp was alive.

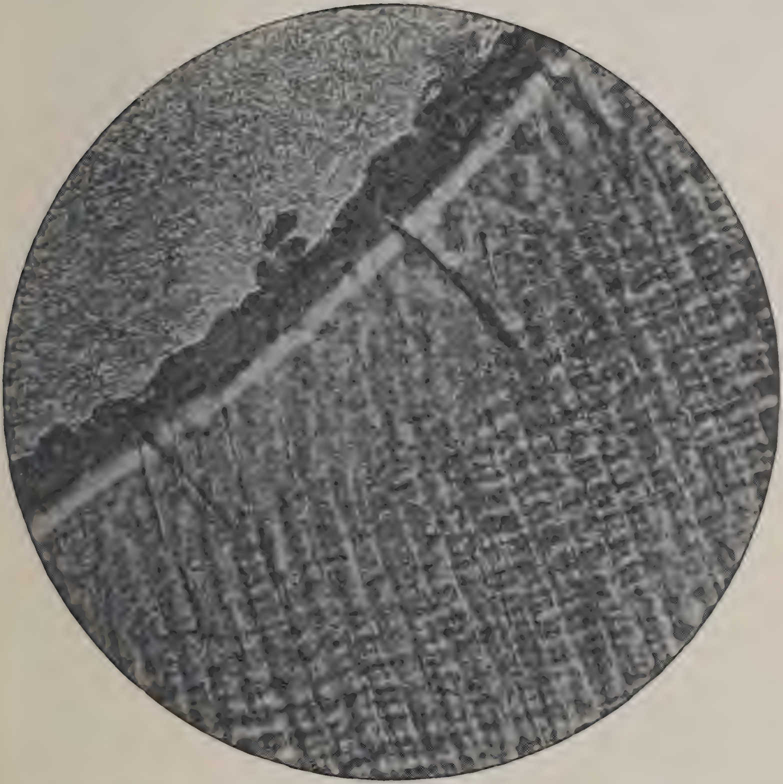


× 800.

FIG. 175.—Showing commencement of caries. Enamel rods separated by solution of cement substance and discoloured by action of acid. From a photomicrograph by Leon Williams.

The theory that translucency is due to decalcification of the matrix is based mainly on the assertion of certain observers that the translucent zone is present in teeth used as artificial substitutes

F. J. Bennett[1] states that in some specimens he has noticed the tubes thickened and enlarged in the translucent zone. He is of opinion that in a specimen of a maxillary first incisor which had been mounted on a plate and afterwards affected by caries he found a translucent zone. It would, however, be exceedingly difficult to prove that the translucency was not present in this tooth prior to its use as a substitute.



× 1,200.

FIG. 476.—Section of carious enamel, showing destruction of tissue by solution of cement substance around enamel rods and globular bodies. From a photomicrograph by Leon Williams.

(ii) *Pigmentation.*—The pigmentation accompanying caries varies from a pale yellow to a black; the more acute the process, as a rule, the lighter the colour. As the discoloration in carious teeth is produced solely by outside agency and is also seen in dentine free from caries it may be safely assumed that it is merely an incidental phenomenon of the disease and not an active agent in producing the disease. The discoloration is in all probability produced by the action of chromogenic bacteria.

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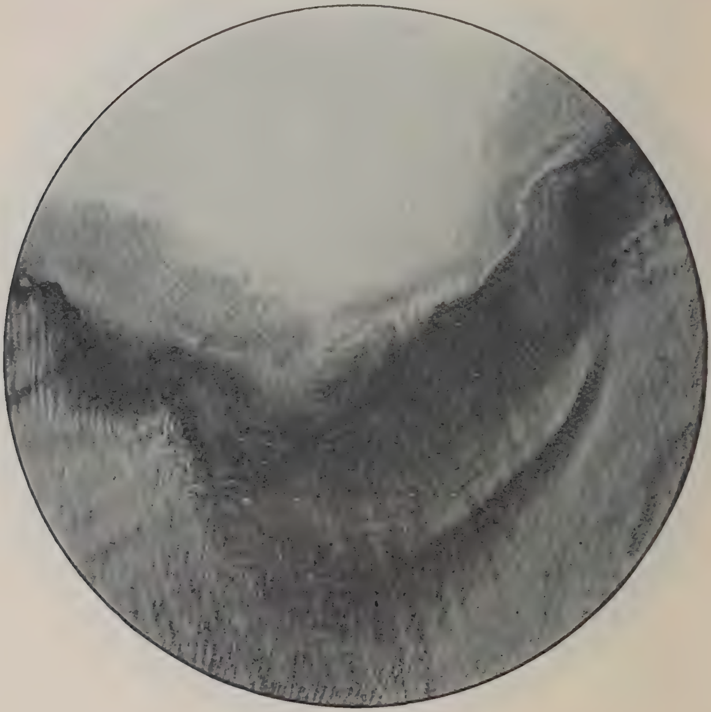
[1] *Trans. Odonto. Soc.*, vol. xxvii, 1895, p. 155.

(2) CHEMICAL CHANGES

The chemical changes which take place in carious teeth consist in a decrease in the amount of lime salts, with loss also of organic matter. In analyses undertaken by Miller it was found that carious dentine contained only about one-thirteenth of its original amount of lime salts, while the organic material was also reduced by two-fifths.



× 300.

Fig. 477.—Section showing progress of slow decay marked by deep discoloration of the tissue. The felt-like mass of micro-organisms on the surface is also seen. From a photomicrograph by Leon Williams.

(3) MICROSCOPICAL APPEARANCES

(*a*) **Enamel.**—For microscopical examination, thin sections must be prepared by grinding and stained to show the micro-organisms.

Sections of carious enamel (fig. 474), according to Leon Williams and others, show that the surface is often covered with a felt-like mass of micro-organisms. The enamel is decalcified between the rods and the interstitial cement substance, the enamel globules thus unbound being either dissolved or washed away. The enamel may be penetrated to a considerable depth before any breaking down of the tissue occurs.

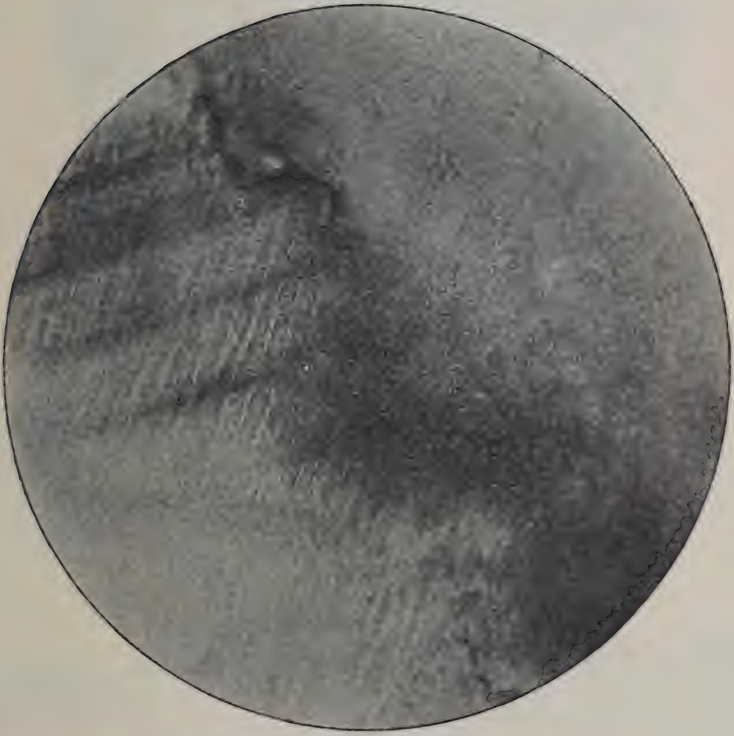

× 800.

FIG. 478.—Similar to the section shown in fig. 477, but under a much higher power. At the upper left-hand corner, the ends of the enamel rods are seen projecting, showing that the cement substance is first acted on by the acid of decay. From a photomicrograph by Leon Williams.

An interesting contribution to the study of caries of the enamel was published by Leon Williams in the *Dental Cosmos*, March, 1897, *et seq.*

The various stages of caries of the enamel are shown in figs. 475 to 478.

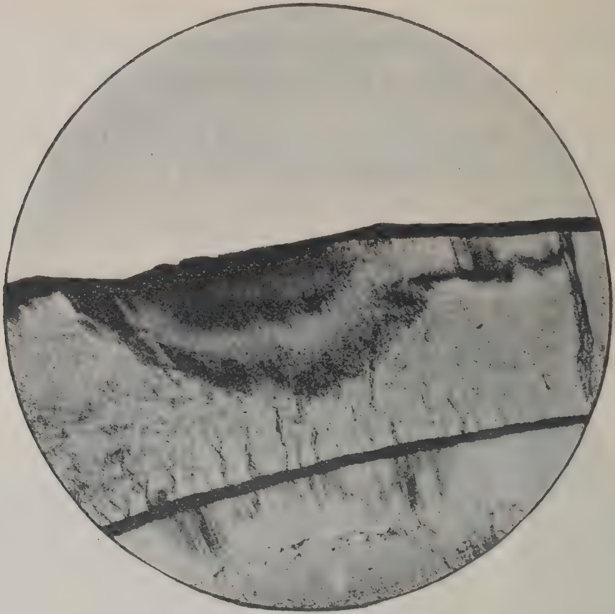


FIG. 479.—Extensive caries without bacterial plaque (Miller). From *Dental Cosmos*.

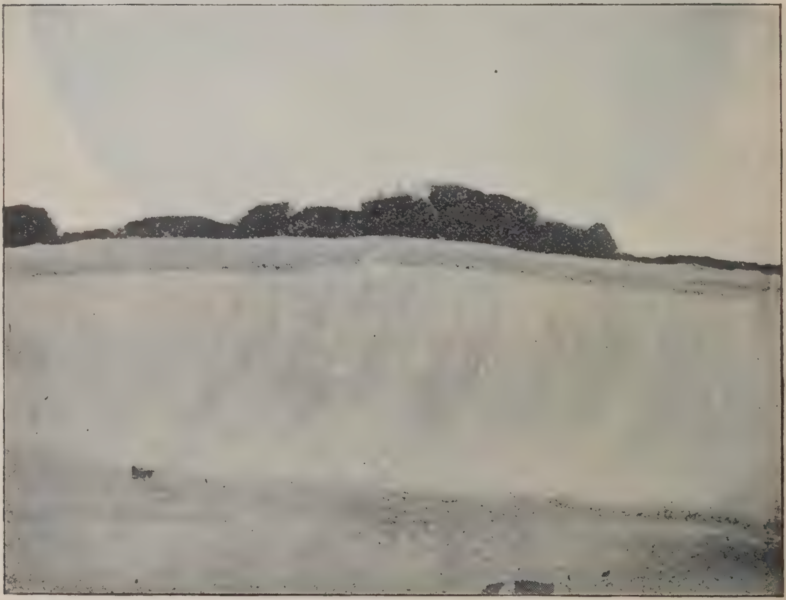
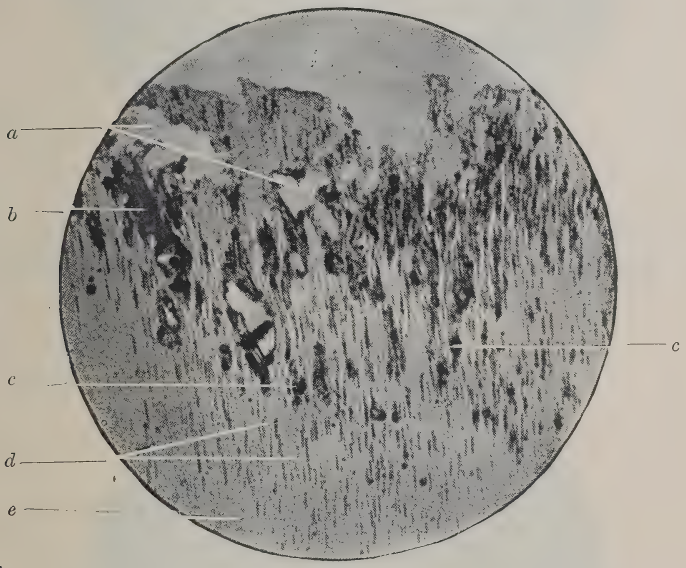


FIG. 480.—Extensive bacterial plaque without a trace of caries (Miller). From *Dental Cosmos*.

The five figures 474 to 478 are from sections of carious enamel prepared by Leon Williams.[1]

In several of the preceding figures a felt-like mass of micro-organisms is seen adhering to the surface of the enamel. Leon Williams and G. V. Black attach considerable significance to these "bacterial plaques." These "plaques" are not a necessary accompaniment of the carious process, and they can, moreover, be demonstrated in teeth without a trace of caries. (See figs. 479 and 480.)

(*b*) **Dentine.**—If longitudinal sections of carious dentine which have been stained to demonstrate micro-organisms be examined microscopically, the following points will be observed.



× 80.

Fig. 481.—Longitudinal section of carious dentine. Photomicrograph by A. Pringle.

Under a Low Power (80 mag.).—Bordering the surface (fig. 481) the dentine is hollowed out in an irregular manner, the cavities presenting no definite shape (*a*). A little deeper in the substance of the dentine irregular masses of stain can be detected (*b*), and, in places, the stain presents a globular appearance (*c*). Lower down, streaks of stain are to be seen (*d*), while still further down the dentine is unstained (*e*).

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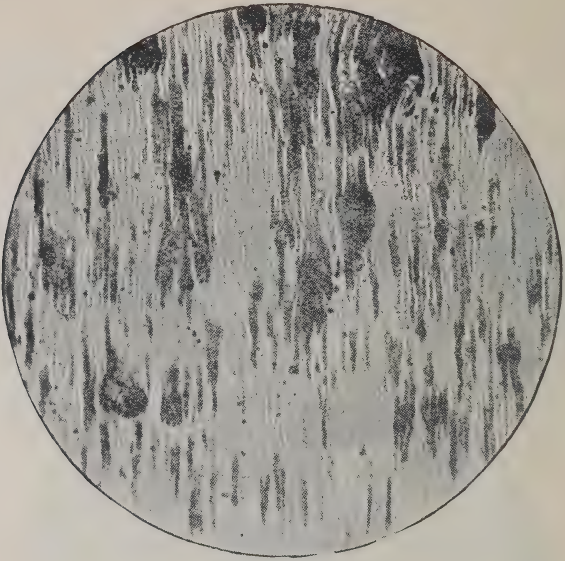
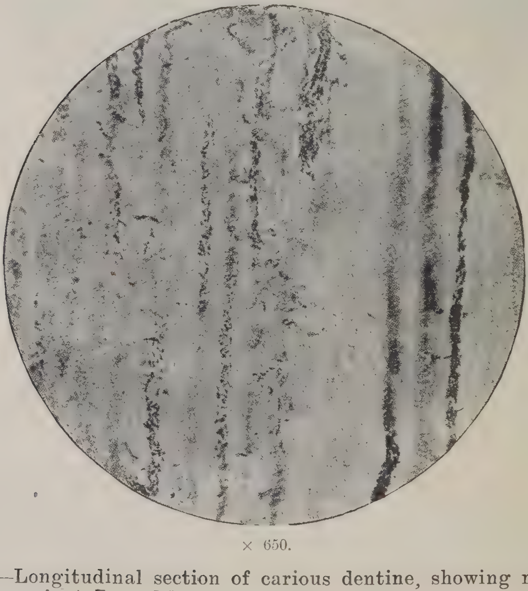
[1] I am indebted to J. Leon Williams for the photomicrographs reproduced in figs. 474 to 478.



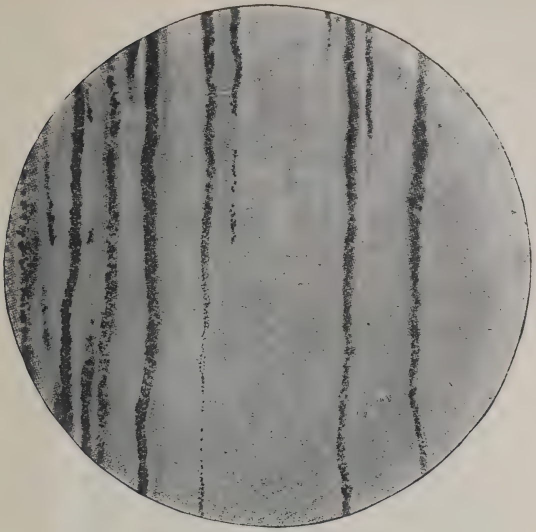
× 150.

Fig. 482.—Longitudinal section of carious dentine, showing liquefaction foci. Photomicrograph by A. Pringle.



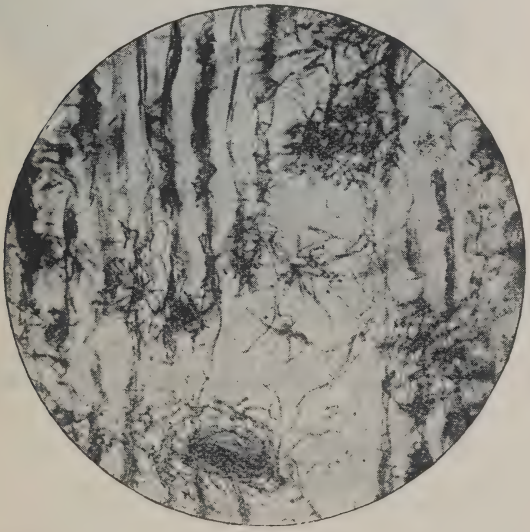
× 650.

Fig. 483.—Longitudinal section of carious dentine, showing rod-shaped organisms in tubes. Photomicrograph by J. Howard Mummery.



× 650.

Fig. 484.—Longitudinal section of carious dentine, showing tubes filled with micrococci. Photomicrograph by J. Howard Mummery.



× 650.

Fig. 485.—Longitudinal section of carious dentine, showing tubes filled with organisms. Photomicrograph by J. Howard Mummery.

Under a Higher Power (150 mag.).—Tracing the process in the reverse order, namely, from within outwards, we notice that:—

(i) The unstained part (*e*) is dentine in a decalcified condition.

(ii) The streaks of stain (*d*) are micro-organisms occupying the dentinal tubes.

(iii) The globular masses are micro-organisms occupying the tubes and the structure between the tubes, in other words, the dentine matrix has disappeared and micro-organisms have taken its place. These globular masses have been termed "**liquefaction foci**" (fig. 482).

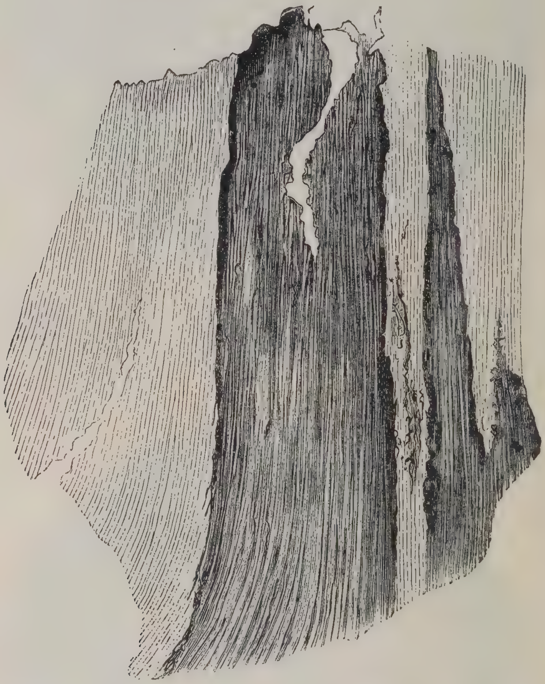


Fig. 486.—Carious dentine, showing that, laterally, the boundary between the infected and non-infected parts may be very regular (Miller).

(iv) The irregular masses are formed by the fusion of "liquefaction foci."

In sections containing interglobular spaces, the spaces are generally seen to be filled with masses of organisms, although occasionally they appear to be quite free from infection. Figs. 483 to 485 are longitudinal sections through carious dentine stained to demonstrate the micro-organisms.

If sections of carious dentine are stained to demonstrate the micro-organisms only, it can be shown that the softening of the dentine precedes the infection. Examine such a section and it will be seen that the softened parts towards the cavity are stained, and towards the healthy dentine unstained, which clearly shows that the softening precedes the infection. Miller has termed the unstained portion the "**non-infected zone.**" The micro-organisms show a greater tendency to spread towards the pulp than in a lateral direction, but this is not always the case where a large number of interglobular spaces are present. The dividing line between the infected and the non-infected zones is often well marked (fig. 486), and though the majority of tubes near the surface are infected, the infection is not noticeable in the deeper parts. Near the margin, leptothrix is mainly found, while the tubes are generally filled with micrococci or simple bacilli. The infection is often of a mixed character. Micrococci and bacilli are usually present and generally in separate tubules.

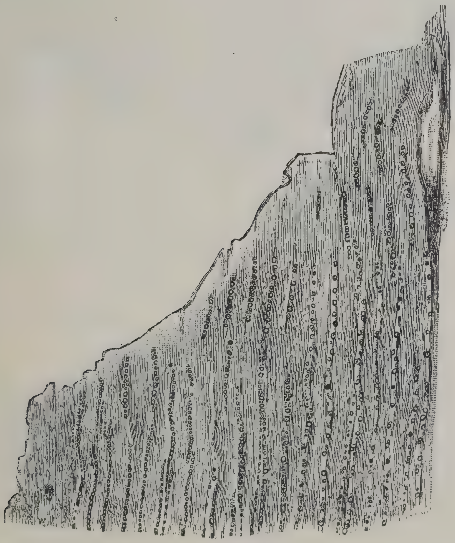
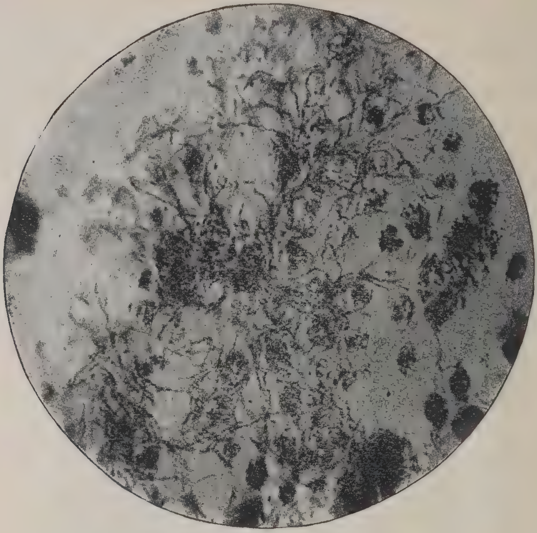


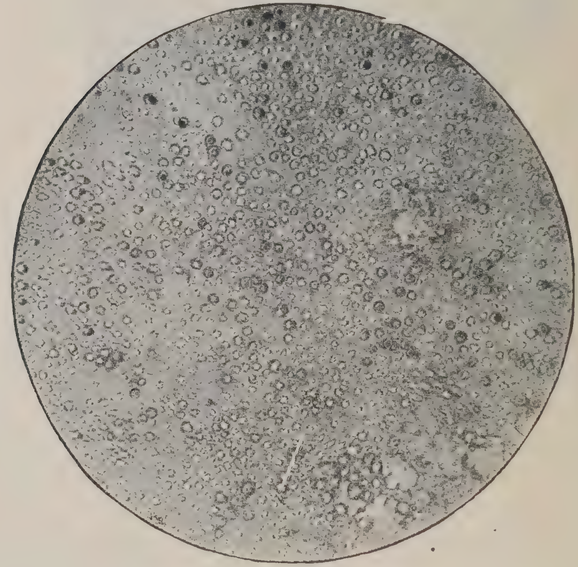
FIG. 487.—Row of shining granules in the tubules from a tooth used as an artificial substitute (Miller).

In addition to micro-organisms, *rod-shaped fragments or elements can usually be demonstrated in the tubules* and are also seen in artificially produced caries. These elements, the source of which is not definitely known, are conjectured to be either (i) portions of



× 650.

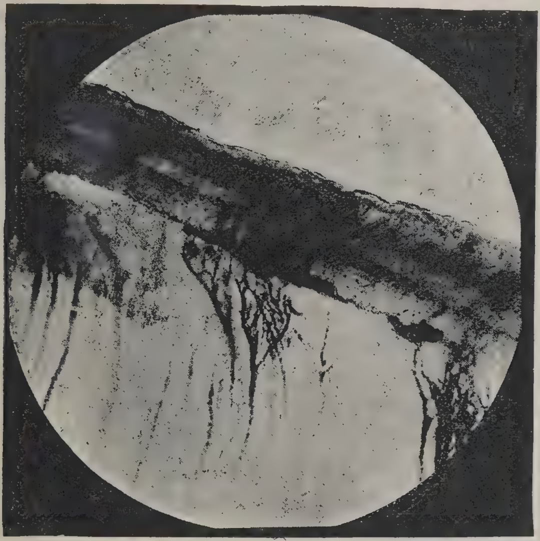
Fig. 488.—Transverse section of carious dentine, showing enlarged tubes filled with micro-organisms.



× 200.

Fig. 489.—Photomicrograph by A. Pringle.

consolidated fibrils; (ii) pieces of the sheaths of Neumann; or (iii) casts of the enlarged fibrils. Miller finds that these elements disappear immediately they are brought into contact with inorganic acids (dilute sulphuric acid), but become more distinct when organic acids are used, and he therefore thinks it probable that they are lime formations. *Rows of shining irregular granules* are also met with generally in the area in advance of the caries (fig. 487). It is possible that these granules have the same origin as the rod-shaped elements, for, if the latter be crushed, granules can be produced.



× 600.

FIG. 490.[1]—Caries in cement. From a preparation by Miller. Photo-micrograph by J. Howard Mummery.

Transverse sections near the carious cavity show the tubes enlarged and filled with micro-organisms (fig. 488). In transverse sections taken nearer to the normal dentine, it is found that the sheath of the dentinal tubes is considerably enlarged, owing, probably, to decalcification. The appearance of the dentine in this condition has been termed the *tobacco-pipe* appearance (Tomes). This is shown in fig. 489.

The tobacco-pipe appearance is also seen in caries occurring in teeth used as substitutes, and in caries produced by artificial means.

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[1] From *Journ. Brit. Dent. Assoc.*

In the *Trans. Odonto. Soc.*, vol. xxiv, p. 90, C. S. Tomes has figured a tooth found in the graveyard of an old church. The cement and dentine of this tooth have been bored in many directions by a fungus, probably the *Saccharomyces mycoderma* (Miller). The penetration of the dentine by *Saccharomyces mycoderma* is, according to Miller, frequently seen in teeth used as artificial substitutes. It is not at all improbable that other fungi may possess the power of penetrating dentine.

F. J. Bennett has recently shown some teeth from graves in Central America, with the dentine almost completely destroyed by a fungus.

(*c*) **Cement.**—Caries of cement (fig. 490) resembles caries of dentine in some details, especially when the micro-organisms penetrate, as they commonly do, along the line of Sharpey's fibres.

There is some reason to doubt whether the destruction of the cement is always brought about by the same process as destruction of the enamel. There are individuals who are free from caries during the greater part of their lives, but who eventually become peculiarly susceptible to caries of the cement.

When cement is exposed the outer layer is liable to be robbed of nutrition and die or to be considerably lowered in vitality. In such tissue autolytic changes may take place, and it is possible that proteolytic enzymes formed from proteid residues or mucus may be responsible for the primary decay in this tissue.

In practice one meets with cases in which the roots of the teeth have been exposed by abrasion, and there is a patch of slightly softened dentine in a position away from the risk of food lodgment. In many of these cases there is an absence of caries of enamel. It is difficult to account for this softening of the cement on the lines of carbohydrate stagnation, and it would seem that other agencies are at work in the production of this condition. In some instances the cavities in the cement are clearly the result of direct absorption of tissue intimately associated with the inflammatory condition of the gum margin.

G. Preiswerk,[1] as a result of experiments, came to the conclusion that caries could occur in an alkaline reaction. The organic ground substance is first destroyed, the disintegration being brought about by proteolytic action, and with the dissolution of the connective tissue the calcium salts fall out. It is possible that the slow destruction of roots, so often seen in the mouth, is brought about by this means and not by acids formed from carbohydrate débris. With the disappearance of the cement, a cavity in time forms which allows of the retention of food débris, and the process may then follow that seen in caries of the enamel.

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[1] "Atlas and Text-book of Dentistry," 1907.

(*d*) **The Effect of Caries on the Pulp.**—This portion of the subject is dealt with in detail in a later chapter treating of the pathology of the dental pulp.

(4) BACTERIOLOGY

The first systematic account of the action of micro-organisms in caries was published by Leber and Rottenstein in 1867. These authors described caries as due partly to the action of acids and partly to the proliferation in the tubes of the dentine of a definite micro-organism, the *Leptothrix buccalis;* they also expressed the view that the growth of the fungus in the substance of the dentine could not take place without a preliminary decalcification of the tissues of the teeth by acid. The acid they believed was formed by the fermentation of the particles of food lodged between the teeth and in fissures on the enamel, and considered it probable that lactic acid was formed in this fermentation.

In 1881 Underwood and Miller showed that caries was absolutely dependent upon the presence and proliferation of micro-organisms. At a later date Miller established the facts that some organisms had the power to produce acids from food-stuffs in sufficient quantity to decalcify the tooth structure; others the power to break down the decalcified tissue; while yet others possessed both properties. In 1883 Miller[1] isolated four different types of bacteria from carious dentine and, five years later, Vignal and Galippe[2] examined eighteen carious teeth, in all of which they demonstrated four types of bacteria, a fifth type was found eight times, and a sixth type five times. K. W. Goadby[3] isolated eighteen types of organisms and divided them into two groups: (*a*) Acid-forming bacteria or bacteria capable of producing acids by the fermentation of carbohydrates; (*b*) liquefying bacteria which, either by their own action or by the production of proteolytic enzymes, cause digestion of the decalcified dentine.

Goadby has also shown that the number and varieties of bacteria on the surface of a carious cavity are more numerous than in the deeper layers; the varieties on the surface of the carious dentine are mostly aerobic liquefiers—many of them liquefy gelatin with great rapidity—and are capable of coagulating blood serum. Most of the organisms which liquefy coagulated blood serum will digest decalcified dentine. A small fraction were anaerobic liquefiers. The organisms from the deeper layers of carious dentine are rarely liquefying bacteria, but nearly all of them are capable of the production of acid from carbohydrates, especially glucose, maltose and lactose. The organisms on the surface of carious dentine often possess the power of discolouring the medium upon which they are originally grown, whilst those from the deeper layers rarely possess this power.

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[1] *Independent Practitioner*, July, 1884.

[2] *L'Odontologie*, March, 1889.

[3] "The Mycology of the Mouth."

Goadby states that not all organisms capable of liquefying nutrient gelatin also possess the power of digesting the decalcified tooth cartilage or chondrinogen. From the deeper layer of the carious dentine he has frequently isolated an organism for which he suggests the name *Bacillus necrodentalis*, and he seems to think that this organism may stand in some causal relationship to caries, inasmuch as its characteristics fit in with the process of decay. In sixteen out of twenty cases he obtained the *S. brevis*, and as this organism and the *B. necrodentalis* are facultative anaerobes and are both acid producers, he considers that they may be largely instrumental in decalcifying the matrix prior to its disintegration by other organisms.

Another organism, hitherto unrecognized in the mouth, has been found by Goadby constantly associated with organisms from the surface of carious dentine, and in two out of twenty cases it was associated with organisms from the deeper layers. This organism, he considers, belongs to *Streptothricæ*, and has been termed by him the *Streptothrix buccalis*.

A careful study of the "Micro-organisms of Dental Caries" has been published by Howe.[1] The investigation was carried out as follows:—

(1) Fillings were inserted over the carious mass, care being taken not to injure the flora in any way; by this means it was hoped that the extraneous flora would die, while the flora that was most resistant in this environment would live. After a period of from six weeks to three months the fillings were removed and the underlying carious dentine was examined.

(2) Fillings having slight antiseptic properties were placed over

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[1] *Dental Cosmos*, October, 1917.

the carious dentine, but left for a much shorter period. This was done in the hope that the bacteria readily affected by the antiseptic would give way to a more sturdy and vigorous flora intimately associated with caries.

(3) The carious dentine in the open cavity was examined. In all cases the carious dentine was removed in three layers: (*a*) superficial; (*b*) middle; (*c*) deep-layer, including dentine apparently unaffected. Cultures were made from each stratum in agar, glucose-agar, bouillon and blood serum. It was found that the only constant flora present belonged to the Moro-Tissier group of organisms, and nothing else was present in the cavities that had had the extraneous flora excluded by fillings, and nothing else was present in 38 per cent. of the open cavities.

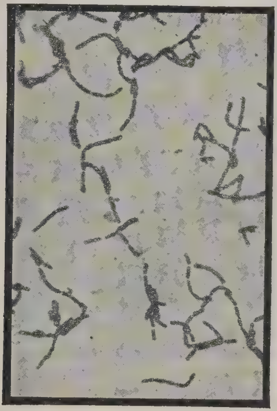

FIG. 491.—Type I bacillus: smear preparation from agar slope culture, showing palisade and chain formation. Gram. x 1,000. From the *Brit. Journ. of Experimental Pathology.*

In the *British Journal of Experimental Pathology* (June, 1922), McIntosh, James and Lazarus-Barlow have described two organisms which they have isolated from carious dentine; the organisms resemble those describeed by Howe but differ from them in certain cultural reactions.

The deeper layers of carious dentine were emulsified in acid broths and, after twenty-four hours incubation, broths of varying degrees of acidity were heavily inoculated and, from these, agar plates were inoculated after twenty-four to forty-eight hours.

"The organisms isolated by the above method fall, morphologically, into two main groups: (*a*) Type I, a long, thin bacillus, 0·75 x 2-3 μ, which occurs singly, in pairs or chains, having a marked tendency to parallelism or palisade formation in dried films (fig. 491); and (*b*) Type II, a shorter bacillus, 0·75 x 1-2 μ, usually occurring in chains (fig. 492). After prolonged subculture on agar, Type I fails to form chains. Both organisms are non-motile and Gram-positive; both are aerobes and facultative anaerobes (in gelatin stab cultures there is equal growth at the top and the bottom). In broth there is in most cases uniform turbidity, but in a few cases the growth settles at the bottom. On ordinary agar the colonies may appear as minute points after twenty-four hours' incubation, but often do not become visible till after forty-eight hours; they are small, round, greyish and opaque, with a finely granular appearance under the low power and a regular outline. In size, the colonies are about 0·5-1 mm. in diameter; on serum agar, rather larger, up to 2 mm. In a gelatin-agar shake culture, the colonies have a rough biconvex appearance which might be described as being 'Tam o'Shanter' shaped."

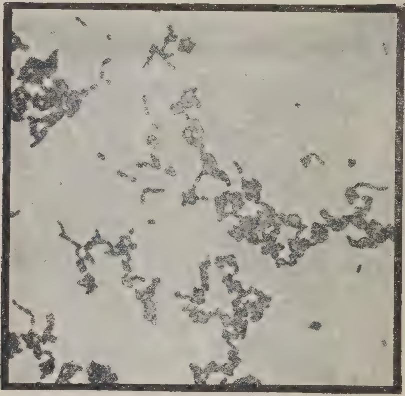

FIG. 492.—Type II bacillus: smear preparation from agar slope culture. Gram. x 1,000. From the *Brit. Journ. of Experimental Pathology.*

Type I was isolated in pure culture from thirty-eight and Type II from eighteen of the fifty teeth examined.

"As regards the fermentation of sugars, of the thirty-eight strains of Type I isolated thirty-three formed acid and no gas in glucose and lactose, no acid nor gas in saccharose, and acid and clot in milk. The milk usually became acid on the second day and was firmly clotted on the third, with all except the top quarter to half an inch completely decolorized. Four of the remaining five strains formed acid in saccharose and glucose, but differed in their reactions in lactose and milk; one strain formed acid in glucose alone. The action of Type II on sugars is nothing like so constant; seven out of the eighteen strains isolated formed acid and no gas in glucose, lactose and saccharose, and acid and clot in milk, the effect on the last-named being similar to that of Type I. Three strains formed no clot in milk after prolonged incubation, and two strains had no effect at all on milk. The remaining six strains varied considerably in their reactions.

"In no case was gelatin liquefied by either type, nor was indol formed; twenty-six strains were also inoculated into dextrin and dulcite without the formation of acid or gas."

The authors have named the organisms *B. acidophilus odontolyticus* I and II.

Mouths of persons who suffered from caries were examined, and cultures of Type I were isolated in 30 per cent. of the cases and Type II in 20 per cent. (See also section on Experimental Reproduction of Caries, p. 358.)

Further researches are necessary before we can assume that the organisms isolated are specific in character or that they are bacteria normal to the mouth which have adapted themselves to an altered environment and have acquired the properties of fermenting sugars.

Adami[1] has directed attention to this power of adaptation in bacteria, and it may be that the organisms isolated are the products of the altered environment of the teeth from modern food-stuffs, and that with the removal of the environment their acid-producing properties would disappear.

(5) THE SOURCE OF THE ACID

The **principal acid formed is lactic,** from amylaceous and saccharine substances which find a lodgment on the teeth and undergo fermentation. In the case of sugars, those belonging to the grape-sugar group, namely, dextrose, levulose, galactose and maltose, are directly fermentable according to the equation

$$C_6H_{12}O_6 = 2C_3H_6O_3$$

Cane-sugar and milk sugar are only fermentable after hydrarization—

$$\underset{\text{(Cane-sugar)}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{(Dextrose)}}{C_6H_{12}O_6} + \underset{\text{(Levulose)}}{C_6H_{12}O_6}$$

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[1] "The Principles of Pathology," p. 101.

The dextrose and levulose are then acted on by the lactic acid ferment.

In the case of starch, the ptyalin transforms the starch into grape-sugar, which is then directly fermentable.

Experiments have proved that, when fermentable albuminous materials are combined with saliva, little acid is formed, which soon disappears; while, when the putrefaction of albuminous substances, such as meat, takes place in the mouth, acids are formed, but they are more than neutralized by the various alkaline products which appear, so that the reaction of the medium is distinctly alkaline. Vegetable food is less likely to ferment when raw than when cooked.

When once decalcification by means of the acids has taken place, the remaining organic portion of the tooth substance is dissolved by the action of bacteria which perform their work by acting upon the dentine in much the same way as the pepsin of the gastric juice acts upon albuminous materials.

Miller[1] and, indeed, most writers believe that the acid is formed from solid food. It seems doubtful, however, whether, in forming this opinion, they have attached sufficient importance to the fermentation of food in a fluid state.

It has been shown that the *primary decalcification of the enamel often starts around, and not at, the point of contact.*[2] This fact would seem to indicate that the food in a fluid condition is maintained around the point of contact by capillary attraction. Again, in mouths kept absolutely free from solid food, caries is often found progressing in pits, fissures, &c., which clearly shows that the disease must arise from the action of fluids, and not solids.

Solid food cannot ferment at the same rapid rate as liquid food, and, moreover, with solid food, a certain degree of solution is necessary in order that the organisms may produce any appreciable change. The reason for the slower fermentation of solid or pulpy substances is that the particles cannot move about so freely as they can in a fluid. With solid substances, the acid formed by the microbe in its immediate neighbourhood cannot disperse, and consequently when the acid has been raised to a certain percentage the action of the organism is inhibited. A full recognition of the fact that food in a fluid state ferments more rapidly than in a solid condition, will help to clear the way to an understanding of the etiology of the disease.

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[1] "Micro-organisms of the Human Mouth," p. 205.

[2] See "The Problem of Dental Caries," S. Colyer, *Dental Record,* vol. xxiv, p. 301.

In the section describing the microscopical phenomena of carious enamel, it was pointed out that a felt-like mass of micro-organisms is at times present on the surface of the tooth. Leon Williams says: " This mass of fungi is so dense and adhesive as to make it highly improbable that the enamel is affected, except in rare or special instances, by any acid other than that which is being excreted by the bacteria at the very point where they are attached to the enamel." This felt-like mass, however, is present in enamel not undergoing caries, and is at times absent in cases where caries is active, and these facts do not support the theory advanced by Williams.

The view that the acid is formed directly from the fermentation of food is not held by all observers. A. Lohmann[1] considers that the mucin is the agent which brings about the decalcification of the enamel, the mucin being set free from its combination with salts by the action of some acid. He states that: " On account of the short stay of carbohydrates in the mouth, but a very slight transformation of the same can take place, whereby only maltose is formed. The production of lactic acid, however, presupposes the formation of grape-sugar, since cane-sugar undergoes no changes whatever in the saliva. Consequently, lactic acid cannot be formed in the mouth."

Clinically, there is evidence to show that mucus is causally related to caries. Children who, in consequence of being mouth-breathers, have developed a marginal gingivitis around the anterior teeth, show a marked tendency to caries on the approximal and labial aspects of those teeth, and this tendency exists even in mouths where every care is taken to cleanse the teeth by artificial means. Mucus secreted by the glands of the mucous membrane often has an acid reaction which is due, according to Kirk, to the presence of acid phosphates of lime and soda. It seems probable that this acid reaction is in some way related to the rapid caries of these cases, and the fact that, in mouth-breathers, the natural cleansing of the teeth is interfered with would appear to support this view.

The views set forth in the preceding pages are accepted by the majority of dental pathologists. R. Eckermann[2] has advanced a theory that caries is in the main due to a difference in osmotic pressure between the fluid contents of the pulp and the saliva, and he maintains that there are two stages in the progress of caries. In the first stage, plasma passes through the dental structures to the outside of the tooth, its passage being largely determined by a direction of lessened resistance. The portion of the tooth invaded by the blood plasma he terms a "carious canal." In the second stage the "carious canal" is attacked by secondary caries, a process which consists in solution of the organic matter, followed by breaking up of the inorganic matter by micro-organisms. The solution of the inorganic matter is, in his view, due to hydrochloric acid, and the micro-organisms find such food as is necessary to their existence in the blood plasma in the "carious canals." The theory is supported by destructive criticism of the chemico-parasitic view, in addition to experiments and observations. His experiments are not conclusive and are capable of a different interpretation from that which he gives. We may quote, in justification of this criticism, his observation of that changed band of tissue which runs from the surface of the tooth to the pulp—the appearance is well known to those accustomed to prepare hard sections of carious teeth. It is this band of tissue which he calls the carious canal and which he considers is due to passage of plasma from the pulp. This transition he believes is due to an increased osmotic pressure of the saliva, consequent chiefly upon the use of salt and, to a less degree, of sugar. A far more reasonable explanation of this band of tissue, and one that is in accord with our views of general pathology, is that the changes observed are due to the natural reaction of the tooth to injury from external stimuli.

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[1] *Archiv für Zahnheilkunde,* June, 1904.

[2] " Dental Caries in Relation to Oral Osmosis."

(D) SPONTANEOUS ARREST OF CARIES

The carious process is occasionally found to have been arrested without any apparent or known cause. In such cases the teeth always show extensive loss of tissue, the enamel of the masticating surface, and often of the sides, having disappeared. The exposed dentine is darkly stained and, to the eye, presents a polished appearance. Probing will show that the dentine is hard, possibly harder than in the normal condition. The appearance of the teeth indicates that the carious process, during activity, was general and rapid in character. Spontaneous arrest of caries may occur either in deciduous or in permanent teeth, but only in those with living pulps. Among permanent teeth, this condition is mostly met with in hypoplastic first permanent molars. Microscopical examination shows that the dentine retains the colour of carious dentine, or is perhaps rather darker. The surface is irregular, the dentinal tubes, which can easily be seen in the discoloured part, apparently ending abruptly on the surface.

In four sections examined, staining failed to show any micro-organism except at those spots where caries was recommencing. (See fig. 493.)

It is not clear how the arrest of the carious process is brought about. Clinical experience shows that when the normal functional activity of the mouth is restored and care is taken to prevent the lodgment of food-stuffs on the teeth, rapid caries may often be arrested. It has been suggested that the hardening of the dentine is due to dehydration, but, as the teeth are constantly bathed in moisture, it appears to be highly improbable that dehydration causes the hardening. It seems far more likely that the arrest is due to some vital activity in the tooth itself, and in favour of this view it is to be noted that the carious process is never arrested in pulpless teeth. Arrest of caries is met with in pulpless teeth, but the death of the pulp always occurs after the arrest of the caries.

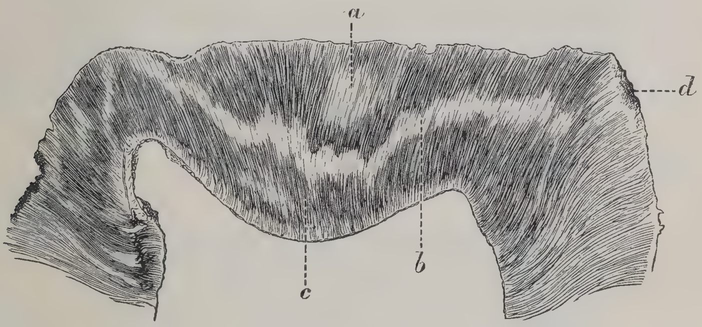

FIG. 493.—(*a*) Portion of dentine in which the decay has become arrested; (*b*) translucent zone; (*c*) normal dentine; (*d*) a softened patch of dentine showing micro-organisms.

(E) EXPERIMENTAL REPRODUCTION OF CARIES

The production of caries in teeth artificially was first successfully accomplished by Miller. Teeth which were perfectly sound, but of various degrees of density, were cut into pieces of different sizes and placed in a mixture of saliva, meat and bread. This mixture, which was repeatedly renewed, was kept for three months at 98° F., at the end of which time there was definite caries of the teeth. With caries produced by artificial means there is no translucency, but translucency probably forms no essential part of the carious process, as it is found in other pathological conditions in the mouth. If the reaction of the solution in which the teeth are placed becomes alkaline, or if the teeth are exposed to the air or to the action of different articles of food, such as coffee, tea, tobacco, fruit, &c., shades of colour are produced similar to those found in the mouth.

M. Choquet has recorded[1] an interesting experiment in which he submitted normal dentine to the action of a pure culture of a micro-organism. From three carious teeth which had been filled he isolated five species of micro-organisms. From one of these he obtained a pure culture and applied it to a small cavity drilled in the incisor of a sheep, the culture being retained in position for nine months. The dentine at the end of this period was found to have undergone certain changes, namely, softening and alteration in colour. The appearances, however, were in no way typical of carious dentine, and it cannot be claimed that artificial caries was produced in this experiment.

Reference has been made to the constant presence of two types of bacilli in carious dentine. If teeth are immersed in broth inoculated with these bacilli, artificial caries is produced. The method adopted was as follows:—

"Non-carious teeth were placed in broth and 2 per cent. glucose broth in 3 in. by 1 in. tubes and sterilized; various strains were then inoculated into the broth, *S. salivarius* in both ordinary broth and glucose broth, and *B. coli* in glucose broth being used as controls. Every eighth day the teeth were removed and placed into fresh uninoculated broth under sterile precautions, so as to approximate somewhat to the conditions in the mouth and prevent the teeth remaining continually in an acid medium."

The longitudinal section of a tooth (fig. 494) which had been kept in glucose broth culture of Type I bacillus for fourteen weeks shows penetration of the dentinal tubes from the pulp cavity side.

The presence of liquefaction foci (fig. 495) is evidence of the power of the same organism to break up the collagen matrix of the dentine.

The action of milk upon dentine has been investigated by F. J. Bennett.[2] Sound teeth were broken into fragments and covered with 50 c.c. to 100 c.c. of cow's milk and kept in an incubator at 35° C. The milk was in some cases changed daily, in other cases every two or three days. "In all cases the milk became curdled and showed an acid reaction to litmus in a few hours; this acidity was strongly marked in two to three days, after which an alkaline reaction set in with a characteristic putrescent smell. In no case was there an admixture of saliva or any other ingredient with the

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[1] International Medical Congress, Paris, 1900, reported in *Brit. Journ. Dent. Sci.*, November 15, 1900.

[2] *Proc. Roy. Soc. Med.*, vol. iv (Odonto. Sec.), p. 3.

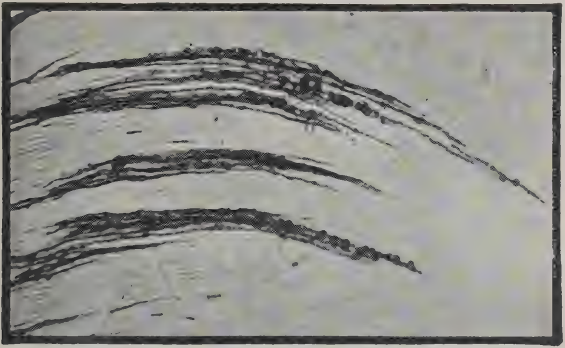

FIG. 494.—Artificial caries; section showing spread of bacilli along the dentinal tubules, which are considerably dilated. × 40.
From *Brit. Journ. of Experimental Pathology.*

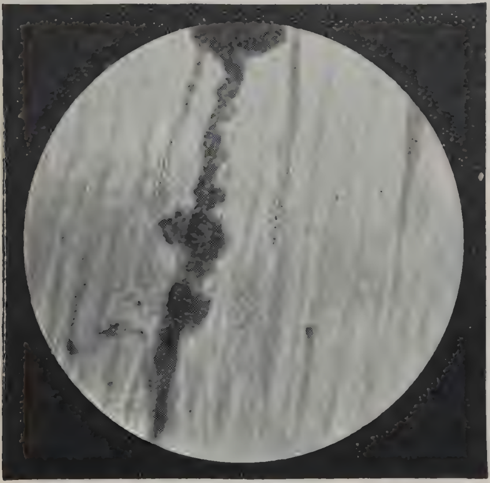

FIG. 495.—Artificial caries; individual bacilli in the dentinal tubules, also liquefaction focus. × 700.
From *Brit. Journ. of Experimental Pathology.*

milk. The dentine became softened with patches of white opacity on the enamel. Sections of the dentine were cut on a microtome, and, on staining, the tubes were found to be occupied by organisms (fig. 496).

(F) SUSCEPTIBILITY AND IMMUNITY TO CARIES

Under this heading various questions connected with the susceptibility and immunity of individuals to caries will be considered.

The Teeth.—Clinical observations show that enamel varies considerably in hardness and also in the rapidity with which it breaks down when attacked by caries. These phenomena are probably intimately connected with the physical and chemical variations of enamel. Pickerill,[2] who has fully investigated the subject, divides teeth into three clinical groups:—

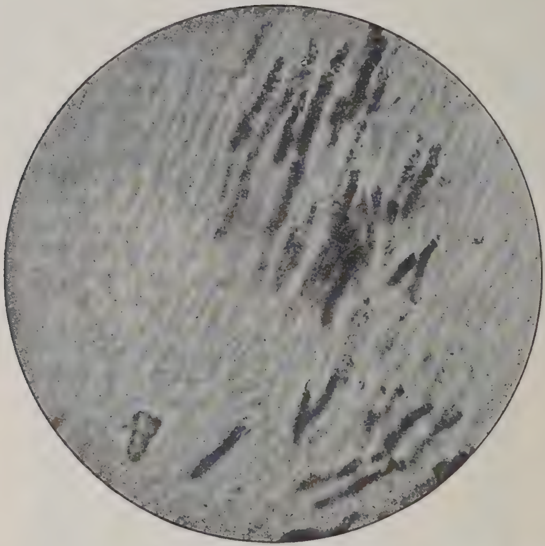

FIG. 496.[1]—Portion of dentine decalcified by acid milk and stained to show micro-organisms in the tubes.

(i) *Native.*—Teeth of primitive races.

(ii) *Sclerotic.*—Teeth usually characterized by their "hardness" and immunity to caries.

(iii) *Malacotic.*—Teeth characterized by their "softness" and susceptibility to caries.

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[1] From *Proc. Roy. Soc. Med.*

[2] "The Prevention of Dental Caries and Oral Sepsis."

For the examination of certain markings on the enamel surface the following method of staining is adopted: The tooth to be examined is washed in water, dried, and the surface cleaned with xylol or ether and alcohol. Graphite is then applied on a soft pad and any excess removed by a piece of smooth rubber. The graphite is thus rubbed into all depressions, whilst it is removed from the

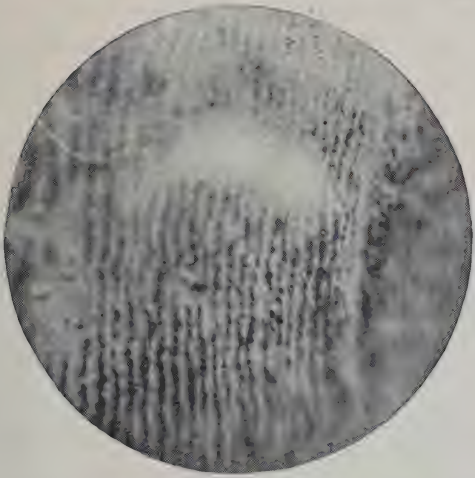

Fig. 497.—Imbrication lines on a malacotic tooth near the cervical region. From Pickerill's "Prevention of Dental Caries" (Baillière, Tindall and Cox).

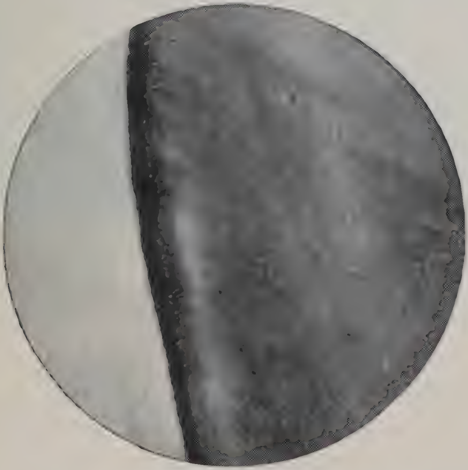

Fig. 498.—Section showing the relationship of the striæ of the enamel to the imbrication lines (low power, reflected light).
From Pickerill's "Prevention of Dental Caries" (Baillière, Tindall and Cox).

elevations. By these means it can be shown that the surface of the enamel is traversed by a series of parallel grooves and ridges, to which Pickerill has given the name "imbrication lines" (fig. 497). These lines are most marked at a point two-thirds of the distance between the neck and occlusal surface and are more defined in malacotic than in sclerotic teeth, and in sclerotic more than in teeth of primitive races.

The imbrications are intimately related to the striæ in the enamel, as shown in fig. 498.

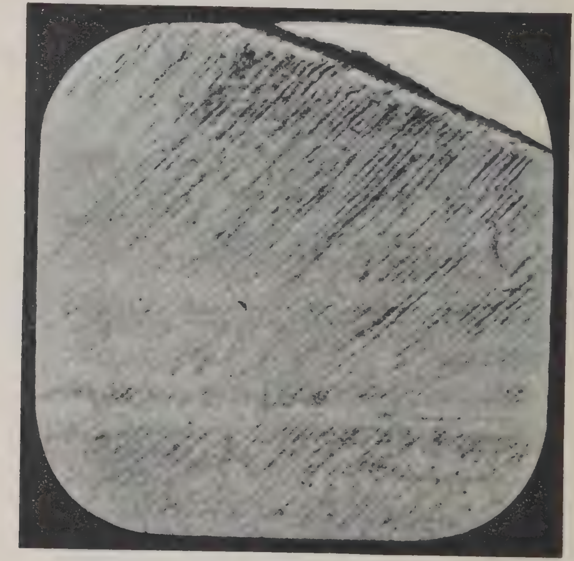

FIG. 499.—Permanent incisor. Interprismatic substance between the prisms, some terminating near the enamel margin where calcification is more perfect. × 200.

From *Brit. Dent. Journ.* Paper by D. Caush.

Well-defined imbrication lines, therefore, indicate well-defined striæ of Retzius and vice versa. There is considerable divergence of opinion as to the cause of the striæ of Retzius, but the view which finds most favour is that they are the result of intermittent or interrupted calcific deposit. If this is the case, imbrication lines can be regarded as an index of the degree of calcification of the enamel.

The view held by C. S. Tomes that the enamel is totally devoid of inorganic tissue seems untenable in the light of recent investigation. Lovatt Evans[1] estimates the organic contents of enamel at 1 to 2 per cent., and this is quite sufficient to account for the histological evidence of organic matter in enamel to which reference will now be made.

D. Caush[2] was, we believe, the first to demonstrate, by means of carefully prepared and stained sections, that the enamel does contain uncalcified material and that the quantity varies in different teeth and in different individuals. The material which takes the stain lies between the prisms and is termed by Caush interprismatic matter (figs. 499 and 500).

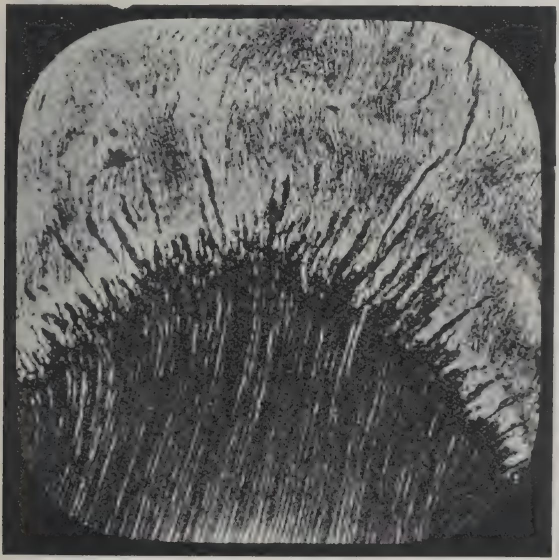

FIG. 500.—Spindles of Von Ebner and stained tubes in the enamel. × 100. From *Brit. Dent. Journ.* Paper by D. Caush.

This uncalcified material can easily be demonstrated by the Von Beust method of staining with alcoholic fuchsin. Pickerill, too, has shown that the enamel is permeable to silver nitrate and that the permeability is greater in malacotic than in sclerotic teeth. An increase in the amount of organic matter probably lessens the resistance of the enamel and influences the progress of caries. This is well shown in fig. 501, which is a section from a tooth with imperfect enamel. The caries has followed the "interprismatic material" and also the lines of the striæ.

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[1] *Trans. International Medical Congress,* 1913 (Sec. of Stomatology).

[2] *Brit. Dent. Journ.,* vol. xxvi, pp. 97 and 901.

It is doubtful if the variations in the amount of uncalcified material can be regarded as accounting for this remarkable difference in the hardness of enamel which is within the experience of every practitioner. The difference in the hardness of enamel is probably due to the quality and not to the quantity of the inorganic salt, but the subject is one which urgently needs careful investigation.

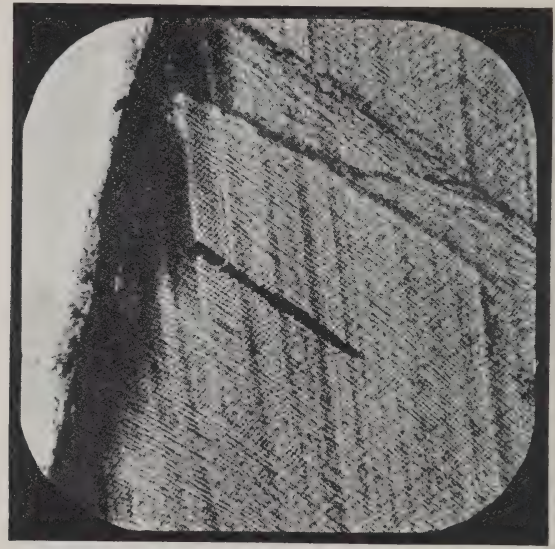

Fig. 501.—Imperfect enamel. Bacterial plaque on surface; large quantity of interprismatic substance; number of striæ; large cavity filled with micro-organisms and caries following the lines of the striæ. × 100.

From *Brit. Dent. Journ.* Paper by D Caush.

In addition to exhibiting physical and probably chemical differences, enamel often shows macroscopical defects in the form of pits and fissures, and such defects may in certain positions provide a lodging-place for food and so render the tooth more susceptible to caries.

Leon Williams,[1] in his paper, "The Pathology of Enamel," states that defects in structure, such as pits, grooves, fissures, pigmentations, granular and amorphous enamel, are common in the lower animals. But the presence of such defects in the lower animals and the absence of caries, from which we know they are comparatively free, is no proof that these defects do not render the teeth more susceptible to caries, when the necessary pabulum exists for the production of lactic acid as in the case of human beings. In the majority of the lower animals the pabulum does not exist and hence no doubt their freedom from caries. The horse may be taken as an example. In the maxillary teeth of the horse a defect is frequently found in the structure of the cemental tissue occupying the anterior and posterior "lakes." The defect takes the form of a canal which persists through the entire tooth (fig. 502), and when caries attacks the teeth of horses it invariably starts in the wall of this canal. L. A. Merillat[2] states that "the entrance of food into these pits causes more than 95 per cent. of the decayed molars of the horse." Horses kept on a diet of hay or grass are free from caries because the mouth bacteria have very slight action on cellulose material and

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[1] "The Pathology of Enamel," *Dental Cosmos,* March, 1907.

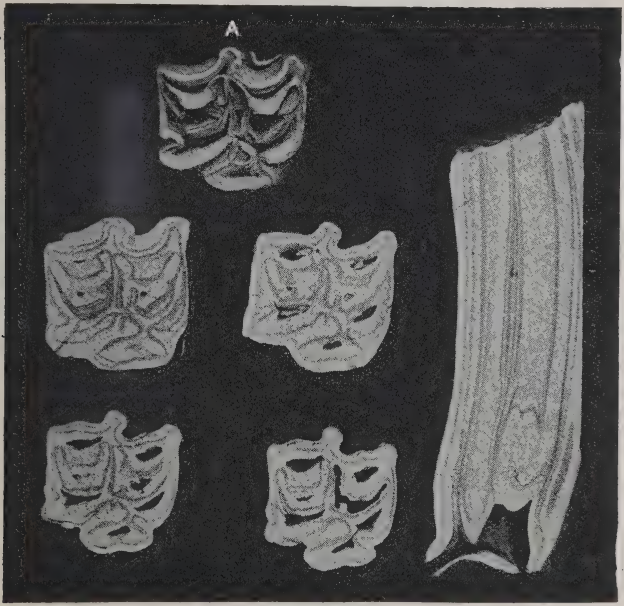

FIG. 502.[1]—In the section (A) the opening of the canal is shown, with the surrounding tissue, in the early stage of caries; the other sections show that the canals exist throughout the tooth.

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[1] From *Trans. Odonto. Soc.*

[2] "Animal Dentistry."

lactic acid is not formed. When corn and other cereals are included in the diet a material is introduced from which lactic acid is formed, and the action of the lactic acid may produce caries which will start, as stated above, at the defective part of the tooth.

Abrasions, bruises and cracks apparently diminish the resistance of the enamel. (See fig. 503.)

In fig. 504 is shown the section of a tooth which Miller immersed for nine and a half months in bouillon composed of water, 100 parts; beef extract, 1·5 parts; peptone, 1·5; sugar, 2 to 3; the solution being neutralized, sterilized and infected with saliva. The tooth at the end of the period was found to be white and chalky, with the exception of a zone of 2 mm. (*a*) and on submitting the section to the 5 per cent. solution of HCl, this zone was found to be the only part of the enamel covered with Nasmyth's membrane.

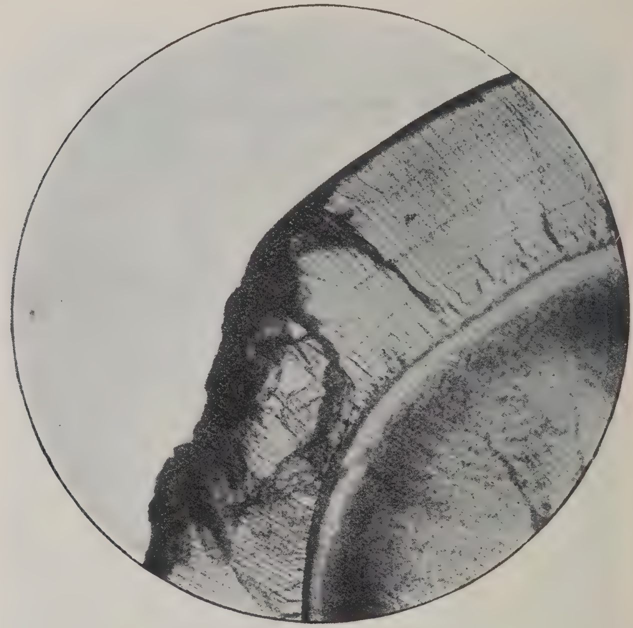

FIG. 503.—Action of acid upon bruised surface (Miller).

From *Dental Cosmos*.

On the approximal surfaces of teeth a patch of quite dark enamel will often be observed. In such cases the carious process in the enamel has been arrested. Miller has shown that these areas are peculiarly resistant. A tooth, a section of which is shown in fig. 505, was placed in a decalcifying solution for two months and then brushed repeatedly. The area of decay was more resistant to the action of the acid and brush than the normal enamel. To these areas of decay Nasmyth's membrane is particularly tenacious. Miller also showed that " the external intact smooth enamel surface offers a most stubborn resistance to the action of weak acids and far greater resistance than the internal surface." (Fig. 506.)

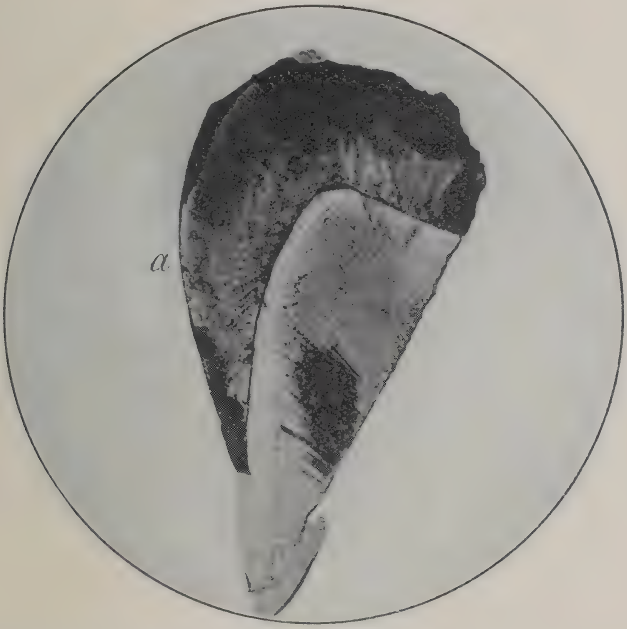

FIG. 504.—Section showing protective action of Nasmyth's membrane at (*a*).
From *Dental Cosmos*.

From the foregoing observations it seems possible that Nasmyth's membrane may protect the enamel to some extent.

G. V. Black[1] and C. S. Tomes[2] have published analyses of dentines and have stated that teeth, clinically known as soft, are not deficient in lime salts, although hitherto supposed to be deficient, and that the molars contain more inorganic material than the incisors. C S. Tomes' figures are as follows:—

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[1] *Dental Cosmos*, 1895.

[2] *Journn. Brit. Dent. Assoc.*, October, 1895.

Incisors: 71·2 per cent. inorganic salts.
,, 28·8 per cent. organic matter and combined water.
Molars: 73 per cent. inorganic salts.
,, 27 per cent. organic matter and combined water.

Black's figures, reduced to percentage of dry dentine, give 71·7 for incisors and 72·3 for molars.

Two sets of teeth were analysed by Tomes to ascertain the percentage of salts. In one set the third molars were largely affected by caries and incipient decay existed between many of the teeth, while in the other set, although much worn by attrition, the teeth were quite free from caries. The analysis gave 71·4 per cent. of salts in both cases, which is below the general average. Tomes has also shown that the dentine, and probably the enamel also, contains water in chemical combination with the various lime salts.

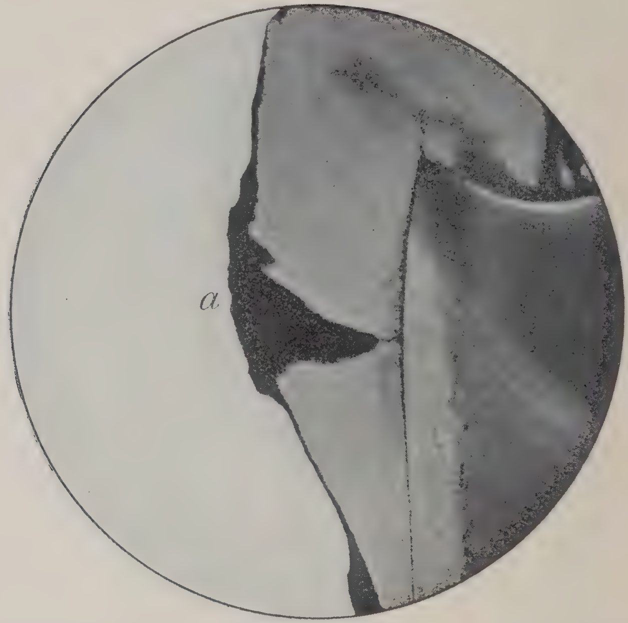

Fig. 505.—Decay mark (*a*) showing resistance to the action of acid and friction more than the sound enamel.
From *Dental Cosmos*.

Black attaches much importance to his own investigation, and considers that "neither the density nor the percentage of lime salts, nor the strength, is in any degree a factor in predisposing the teeth to caries or in hindering its inception or progress." The important point, however, is not the percentage of lime salts in the teeth so much as the stability of the compound which these salts form with the organic matrix of the tooth. The analyses of Black and Tomes are unfortunately in no respect qualitative and do not bring out the varying proportions of the different salts.

Experiments on the resistance of dentine to acids were carried out by Miller.[1] The results he obtained force one to the conclusion that the resistance which dentine from the teeth of different animals offers to the actions of acids varies very greatly. Experiments with yellow teeth and weak bluish teeth showed "that there is a difference in the rapidity with which dentine from different teeth is acted upon by weak acid under the same conditions and that this difference will usually be found to be in favour of so-called hard dentine. The difference is not sufficiently great, however, to confer immunity upon the one tooth, while the other falls a prey to caries. It is

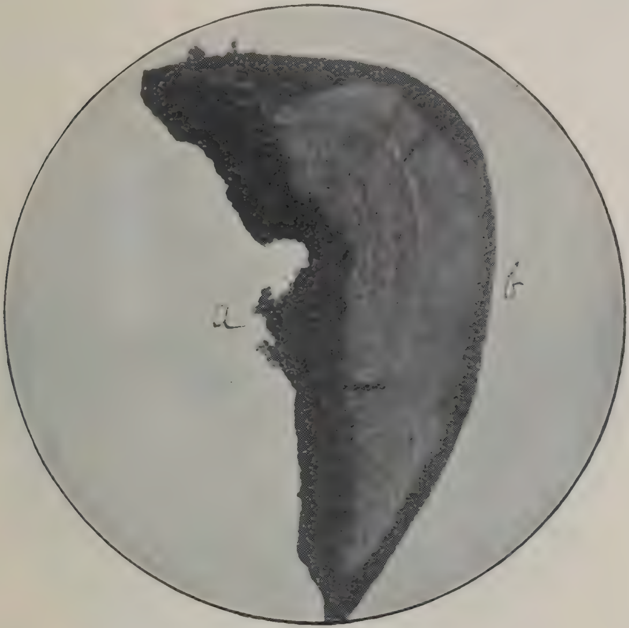

Fig. 506.—Unequal action of acid upon internal (*a*) and external (*b*) surfaces. (Miller.)

From *Dental Cosmos.*

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[1] *Dental Cosmos,* September, 1903, p. 696.

only one of the factors, which again must not be completely lost sight of."

The amount of reaction which takes place in teeth with living pulps probably influences the progress of the caries. The reaction of the tooth to the carious process manifests itself in the formation of secondary dentine and in a change in the contents of the dentinal tubes, giving rise to the "translucent zone." Experiments show that the dentine of the "translucent zone" and secondary dentine "offer a greater resistance to advancing caries than normal dentine" (figs. 507 and 508).

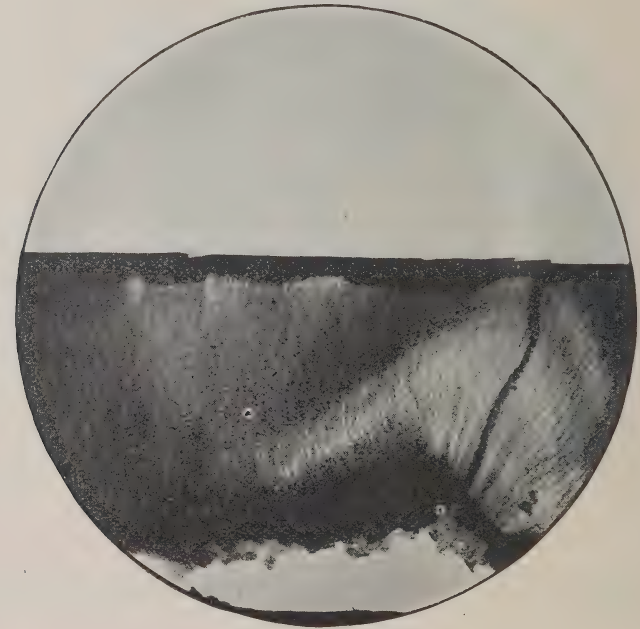

FIG. 507.[1]—Showing the influence of transparent dentine in the process of decalcification. (Miller.)

The Influence of Lime Salts in Food.—Röse, of Freiburg, has made extended investigations as to the influence on the teeth of lime salts in food and water. His inquiries have been pursued in many countries, and he has arrived at the conclusion that in districts where the soil and drinking water are rich in lime the teeth are sounder than in districts where the lime is deficient. The following figures show the results he obtained from Baden and Thuringia:—

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[1] From *Dental Cosmos.*

(1) Country Places poor in Lime.

	Percentage of children with caries.	Percentage of diseased teeth.
In Baden	98·7 ...	35·3
In Thuringia	92 ...	34·9

(2) Country Places rich in Lime.

	Percentage of children with caries.	Percentage of diseased teeth.
In Baden	79 ...	16·1
In Thuringia	82·8 ...	16·7

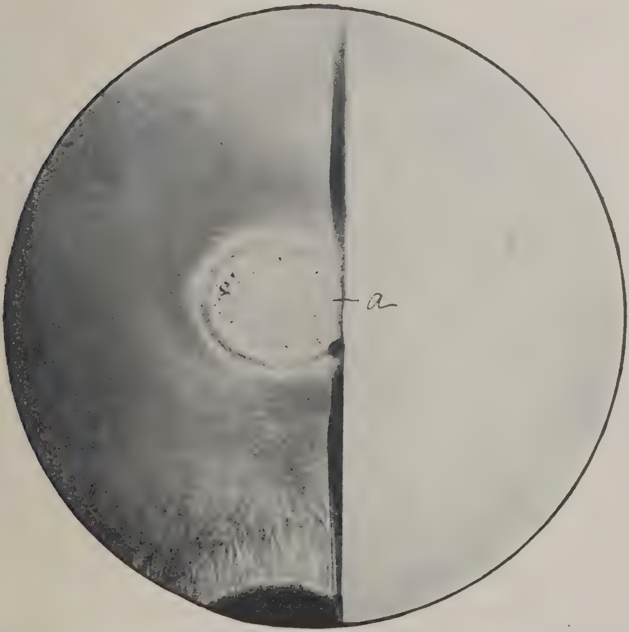

FIG. 508.[1]—Evident superior resistance of secondary dentine to decalcification at (*a*). (Miller.)

Röse found a remarkable difference in the amount of caries in children at two villages, Guntersthal and Uffhausen, only about three kilometres apart. At the former, where the geological formation is gneiss and the water 1·7 to 2·8 degrees of hardness (German calculation), in 118 children 34·6 per cent. of the teeth were carious, while at Uffhausen, where a Jura-lime formation exists, and the water was 14 to 19 per cent. of hardness, in 162 children the percentage of carious teeth was only 20·7.

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[1] From *Dental Cosmos.*

J. B. Cook[1] has investigated the subject in 80 urban districts in England and Wales. He finds that the harder the water the better the teeth, and, what is also of interest, that the harder the water the lower the infantile mortality. The relation of the hardness of the water to the incidence of caries must not necessarily be regarded as cause and effect but rather as a factor in the degree of relative immunity.

The effect of the calcareous content of drinking-water upon the incidence of caries in Switzerland has been investigated by P. Walter.[2] Two places were chosen, Stilli in Aargau, 328 metres above sea-level, with very hard water, and Engelberg, in Obwalden, 1,019 metres above sea-level, with very soft water. In Stilli the percentage of persons with carious teeth was 18 per cent. as against 36 per cent. in Engelberg.

The Type of Organisms present in the Mouth.—Investigations carried out by Pickerill and Champtaloup[3] show that in Maori children, who are comparatively immune to caries, the organisms present in the mouth are morphologically similar to those found in the mouths of individuals belonging to the more highly civilized communities; a fact which indicates that susceptibility and immunity to caries do not depend upon the bacteriological flora of the mouth.

The position of the teeth in relation to one another has an important bearing on their liability to caries. When they are in regular position the surfaces are easily kept clean by artificial means, such as the tooth-brush, silk and tooth-pick in conjunction with the natural cleansing action of the tongue and lips; but when they are placed irregularly inaccessible crevices are formed. Again, the teeth, when normally placed, only just touch one another at the crowns and the space at the necks is occupied by gum which prevents the lodgment of food. Any agency, therefore, which operates to change these conditions, for example, causes a loosening or recession of the gum, acts as a predisposing cause of caries.

The Self-cleansing Action of the Mouth.—If a series of mouths be examined about fifteen minutes after a meal it will be found that the amount of food débris present varies; in some mouths the teeth will be entirely free from food while in others there will be a considerable deposit around and between the teeth. It is obvious, therefore, that some mouths are self-cleansing and others are not, and it is highly probable that the character of the mouth in this respect affects the relative immunity or susceptibility of the teeth to caries. F. Breeze[1] has recorded some interesting facts in connection with this question. In schools brought under the same dietetic regime and the same discipline with regard to artificial cleansing of the teeth, he found that the incidence of caries was in ratio with the self-cleansing action of the mouth. The children were inspected immediately after meals and the degree of cleanliness of the mouth noted. During one inspection, he found that (1) of 39 children (immune), in only 7 cases was food found and then only on the occlusal surfaces of the molars; (2) of 30 children (non-immune), 21 cases had food remaining on the teeth and in 7 of these there was marked accumulation.

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[1] "The Effects of Drinking-water upon the Causation of Dental Caries in School Children," *Lancet*, March 28, 1914.

[2] Quoted in *Brit. Dent. Journ.*, vol. xliii, July 15, 1922, from the *Schweizerische Monatsschrift für Zahnheilkunde*.

[3] *New Zealand Dental Journal*, March, 1914.

The Possibility of the Formation of Antibodies in the Teeth.—Von Beust[2] has shown that if the ends of the roots of freshly extracted teeth are immersed in a strong alcoholic solution of fuchsin the crowns will in time take on a reddish hue, which is due to the passage of the stain from the pulp cavity into the enamel. He therefore assumes that plasma "can reach all parts, generally speaking, of the enamel and that this renders it possible, nay, even probable, that the immunity to caries observed in some teeth lies in the tooth itself and is the result of the formation of antibodies." He does not, however, exclude the saliva as an active factor making for immunity.

The Saliva.—A strong flow of saliva flushes the mouth and removes particles of food from the teeth. Miller affirms that he has repeatedly found that a cessation or a marked diminution in the secretion of saliva is followed by acute caries which attacks nearly all the teeth simultaneously and often extends upon the free surfaces. A viscid saliva may also conduce to caries by interfering with the self-cleansing of the mouth. It seems possible also that the susceptibility to caries may be influenced by the constitution of the saliva, for Miller,[3] as the result of many experiments, came to the conclusion that "the saliva of those immune to caries develops in the presence of carbohydrates, in and out of the mouth, on an average a little less acid than that of highly susceptible persons. The difference is, however, not constant, and is not sufficiently marked to account for the marked difference of susceptibility.''

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[1] *Brit. Dent. Journ.*, June 16, 1913.

[2] *Dental Cosmos.*

[3] *Dental Cosmos*, 1903, p. 689.

Röse[1] has analysed the saliva of 219 children whose average age was 13 years, and he concludes that a distinct relation exists between dental caries and the alkalinity of the saliva. He finds that a high alkaline reaction constitutes the best means of checking the progress of caries. He has carried out a considerable number of experiments to determine the means by which slightly alkaline or acid saliva may be modified so as to render its reaction decidedly alkaline. He finds that a diet consisting of food-stuffs rich in calcium salts increases the alkalinity and quantity of the saliva and he believes that such a diet favourably influences the quality of the teeth. In this connection it is interesting to note that Miller, in comparing, experimentally, equine and human saliva, found that in equine saliva no acid was produced during the first twenty-four hours, and that the total amount at the end of nine days was 50 per cent. less than in human saliva. Equine saliva is strongly alkaline and therefore more readily neutralizes any acid formed. In Chapter XIX reference is also made to the part played by saliva in relation to caries of the teeth.

The Relation of Sulpho-cyanide of Potassium to Caries.—Opinions differ as to the relation of sulpho-cyanide of potassium to caries. This salt is a normal constituent of saliva, forming about 0·1 of the total solids. Gies[2] has made a thorough investigation into the subject and finds that "there is nothing about the known quantities of sulpho-cyanide to indicate that it is able, *in the proportions of its normal occurrence in saliva*, to affect the secretory tendencies of the salivary or buccal glands, to modify the oral membranes, to influence the teeth from any standpoint, or to stimulate or retard or alter the activities of the oral micro-organisms.''

Vaccination.—So profound a thinker as Herbert Spencer hazarded the suggestion that vaccination might increase the susceptibility of the teeth to caries. This view is shared by a few dental practitioners. D. V. Peacock[3] considers that vaccination is a prime factor in the destruction of children's teeth, his argument being that it leads to imperfect development of the tooth structure.

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[1] *Deutsche Monatsschrift für Zahnheilkunde,* December, 1905.

[2] *Dental Cosmos,* February, 1914.

[3] *Dominion Dent. Journ.,* December, 1901.

Reliable statistics in support of this view are not, however, forthcoming.

Pregnancy.—It is a current belief that there is increased susceptibility to caries during pregnancy and it has been assumed that this is due to the absorption of the mineral matter from the teeth to form fœtal bone. From a physiological point of view there would appear to be no foundation for this belief. S. Biro[1] has examined the teeth of 200 mothers and the results he obtained tend to show that pregnancy does not cause any increase in caries of the teeth. During pregnancy certain women often seem more liable to caries, but an explanation may be found in some change of the oral secretion whereby a more favourable soil is produced for the development of micro-organisms. It is possible that the vomiting of pregnancy may, to some extent, aid the development of caries. This alleged predisposition of the pregnant to caries is by no means a matter of general experience, and in practice one meets with many instances of women with large families who have excellent teeth and who develop no increased susceptibility to caries during the pregnant period.

The Influence of Feeding in Infancy.—Kingston Barton,[2] as a result of twenty years of observation, finds that breast-fed children have the best teeth; those fed on cows', asses' or goats' milk come next, and that when starch or any patent food is added to or given in place of cows' milk, the teeth, both deciduous and permanent, almost always suffer severely. The figures published in the report of the Salop County Council show that the incidence of caries in breast-fed children is only slightly less than in the bottle-fed. The figures are as follows:—

	BREAST-FED CHILDREN		BOTTLE-FED CHILDREN	
Age	Number of children examined	Number of carious teeth per child	Number of children examined.	Number of carious teeth per child
5 to 6	5,707	6·7	3,375	7·1
12 ,, 13	3,571	4·7	1,900	5·0

Adenoids.—Statistics show that caries is more prevalent in mouth-breathers than in nose-breathers, and this is no doubt due to the facts that in the mouth-breather (1) food débris is more liable to cling around the teeth, and (2) the number of micro-organisms is increased. The following figures published by H. R. Burpett[3] are of interest:—

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[1] *Oesterreich-Ungarische Vierteljahrsschrift*, October, 1898.

[2] *Medical Press and Circular*, vol. ii, 1899.

[3] Quoted in *Dental Record*, November, 1916, p. 603.

	CHILDREN WITH ADENOIDS			ALL CHILDREN		
	Infants Per cent.	Intermediates Per cent.	Leavers Per cent.	Infants Per cent.	Intermediates Per cent.	Leavers Per cent.
Teeth excellent	7	10	12	13·2	12·6	18·5
Four or more teeth carious	33·5	28	12	26·4	21·4	10·4

Poverty.—In discussing this aspect of caries, comparisons will be drawn between the various classes of children who attend State schools. Statistics show that amongst such children the poorest have the best teeth. The following figures are taken from an inspection of children in Staffordshire[1]:—

	Age 5–6		Age 8—9		Age 12—14	
Sound dentures among—	Number examined	Per cent.	Number examined	Per cent.	Number examined	Per cent.
(*a*) All children coming from houses, one to three rooms	478	23·2	379	12·6	159	22·6
(*b*) All the other children attending the same schools as the children in (*a*)	2,434	20·2	2,445	7·5	1,025	18·2
(*c*) All the children of all the schools of the county	6,485	18·3	6,198	8·4	3,421	18·9

The general high percentage of sound dentures requires a word of explanation. In the inspection no probe or mirror was used; hence many carious cavities must undoubtedly have been overlooked. The figures, however, are comparative and distinctly show that the poorest children have the best teeth. The poorest children have the most simple food, while lack of means prevents the purchase of cakes and sweets, and the better preservation of their teeth is probably due, therefore, to the comparative absence of the highly fermentable carbohydrates from their diets.

(G) ETIOLOGY

In the preceding pages it has been shown that caries is a process which is started by solution of the inorganic matter of the teeth and continued by the peptonizing action of bacteria on the remaining organic tissue, and that the acid or acids which cause the damage are formed from the carbohydrate food undergoing fermentation in contact with the tooth substance.

We have seen that caries existed as far back as the time of Rhodesian man. In the early stages of civilization a definite increase in the amount of caries can be traced, and with the spread of civilizing influences the disease has made more and more rapid progress until at the present day it is so prevalent that few are to be found with teeth entirely free from caries.

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[1] Annual Report of the School Medical Officer, Staffordshire County Council, year 1911.

Caries in primitive races was probably due to circumstances and conditions unlike those which lead to the extensive destruction of teeth at the present day. In primitive races the disease was of a more chronic type and usually followed injury of the dentine or cement—in other words, it did not arise, as in the present day, as a direct attack on the enamel.

B. Nicholls[1] has drawn attention to the close relationship of attrition of the teeth to caries in the aboriginal Australian race, and he says that in his investigation " approximal caries was often associated with approximal and occlusal cavities in adjacent teeth, in which pulps had been exposed by excessive attrition." He also remarks that dental caries in aborigines is mainly a disease of middle and old age, and one of its chief predisposing factors is " natural " destructive attrition.

Mummery in his investigations paid particular attention to this question of destructive attrition, and showed that attrition is not an index of hard food but rather of the degree of hard, earthy matter, such as sand, incorporated with the food and not eliminated in its preparation.

When there is destruction of the teeth by attrition the enamel is liable to flake off and so lead to a catchment area. The Esquimaux, Maori, and North American Indians (Coast) skulls examined by Mummery showed a considerable degree of destructive attrition, but caries of the teeth was rare. The liability to caries in races showing extreme attrition of the teeth would seem to depend upon the type of food which is collected in the catchment area.

In referring to caries in animals, attention was directed to the fact that, when seen in skulls of animals from the wild state, the caries seemed to follow either injury of the cement at the cervical margin or exposure of the dentine by fracture of the teeth; whereas in the animals kept in captivity the enamel was generally the part attacked. It seems possible that the destruction of the cement and dentine seen in caries in some primitive races and in animals in the wild state may be of the nature of an autolysis, or may be due to proteolytic action, and not to the formation of lactic acid from carbohydrates.

The phenomenal rapidity with which caries has increased during the last few decades has puzzled those who have studied the subject.

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[1] *Trans. Sixth Inter. Dent. Congress*, p. 79.

Considerable light has, however, in recent years been thrown on the problem by those who contend that a solution is to be found in the altered character of the food-stuffs. In a series of valuable papers, Sim Wallace has drawn attention to the influence which the refinement of food has had on the process of mastication, and he has clearly pointed out the intimate relationship which this change bears to the incidence of caries. To appreciate the standpoint taken up by this writer, reference must be made to the process of mastication of food of a soft character, and of food containing coarse or fibrous material. In the former case " The food is simply taken into the mouth, receives a general squash between the teeth, or between the dorsum of the tongue and the hard palate, and is then swallowed. This method of mastication—if mastication it can be called—is, as a rule, adopted for custards, fine meal porridge, soft puddings, and soft non-fibrous foods generally. When there is a certain amount of coarse or fibrous matter in the food-stuff, the process is essentially different, and mastication is performed in a more thorough manner. The food is crushed and torn between the teeth and heaped on to the masticating surfaces by the muscular contractions of the tongue, cheeks, lips, and motions of the lower jaw. During comminution between the teeth, the juices of the food-stuffs, the saliva which becomes incorporated, and the suspended non-fibrous part are pressed out from the fibres and gradually collect during the process on the middle of the dorsum of the tongue, which is gradually hollowed out for the reception of such food, and this portion of the food is then swallowed. The fibrous part of the food, however, is subjected again and again to the crushing and disintegration between the teeth. If any of the fibrous part passes towards the back of the dorsum of the tongue, it is arrested by the pressure of the anterior part of the tongue against the rugæ of the palate, and while the fluid and finely comminuted part gets sucked or pressed back into the hollow formed at the back of the dorsum of the tongue, the coarse and fibrous parts are thrown between the teeth and subjected again to the crushing, squeezing and comminution. The rough surface of the tip and dorsum of the tongue and the smooth-ridged palate are especially well adapted for separating the food which is prepared for swallowing from that which requires further mastication."

" If this process is carefully observed, it will be found that the food is not, as a rule, formed into a bolus and then swallowed, but that the bolus is continually slipping away to the dorsum of the tongue, to be swallowed only when there is almost or quite no bolus left." (Sim Wallace.)

The recognition of the real nature of the process of mastication is, in this author's opinion, of great importance, for the effect of chewing food of a more or less fibrous nature tends to dislodge the fine particles of food-stuffs which otherwise are apt to remain between and on the teeth.

If we examine the food-stuffs as prepared for the table at the present day, we find that every care has been taken to eliminate the fibrous element, and that they are usually presented in such a soft condition as to require very little mastication; indeed, it is extremely difficult, even with the best intentions, to masticate such food. The process of mastication, therefore, remains in abeyance, and the result is that, owing to the pappy character of the food, and the absence of the cleansing operation of mastication, the food tends to cling around the teeth. Sim Wallace contends that herein lies the true cause of the prevalence of caries. He says: "The cause of the prevalence of dental caries is that the natural food-stuffs are to a large extent ridded of their accompanying fibrous parts and prepared and consumed in a manner which renders them liable to lodge and undergo acid fermentation in the mouth; while from the same cause and the induced condition the micro-organisms of the mouth lodge, multiply and augment the rapidity and intensity of the acid fermentation."

In opposition to these views it is argued that there are numerous examples of races living upon soft food and yet not unduly liable to caries. The Kaffirs of South Africa are given as an instance. But the porridge of the Kaffirs, which is their staple food, is prepared by bruising and crushing mealies, no attempt being made to eliminate the coarse and fibrous parts, and experience shows that such food *does* require a considerable amount of mastication.[1]

My brother, S. Colyer, who has lived for several years among the races of Central Africa, states that the diet of many of these people is mainly "grain," and that it is prepared for eating in a "stodgy, elastic and rather sticky mass," which requires but little mastication. The natives do not clean their teeth after meals, and their diet is practically free from "acid and saltish savouries." The food, however, is practically free from easily fermentable carbohydrates, in the form of the *various* sugars. These races have very little caries, and it would therefore seem that caries cannot be solely attributed to soft, sticky, starchy foods.

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[1] References to this question will be found in the *Lancet*, September 8, 1900, p. 770; November 3, p. 1307; *Brit. Med. Journ.*, March 18, 1905, p. 629; April 1, p. 749.

Although there is much to be said in favour of Sim Wallace's view, it is very doubtful whether it offers a complete solution of the problem. It is more highly probable that there have been other agencies at work tending to accelerate the progress of caries. The use of carbohydrates has probably had an important influence in this direction. *Carbohydrates as used at the present day are more easily soluble and fermentable than heretofore*, and within the last fifty years have undergone an extraordinary amount of variation. Flour is a typical example. In flour the change has been brought about by the altered method of milling. Milling with the old stone mills excluded no part of the grain except the greater portion of the husk, whereas with roller milling the germ is removed and practically all the bran, the flour consisting almost entirely of starch and gluten. With regard to the question of caries, bread made from stone-milled flour requires more mastication and insalivation than that made from the roller-milled, and what is probably more important still is that the much finer subdivision of the starch granules in the roller-milled flour offers an increased surface for the action of fermentation.

It has been said that the acidity produced by white flour is greater than that of stone-milled flour. Experiments carried out by Leonard Hill[1] do not confirm this statement. This author tested the acidity of a weighed quantity of standard and white bread chewed in the mouth for two minutes and found no difference in the amount of acid produced. The subject, however, is deserving of serious attention, seeing that bread and flour form the most important item in the diet of the masses.

The increased consumption of biscuits is probably in some measure responsible for the prevalence of caries. In biscuits the carbohydrate is in a peculiarly sticky form, and, if milk is taken at the same time, all the pabulum necessary for the rapid production of lactic acid is present in the mouth. The rapid and extensive caries seen in young children can often be traced to biscuits and milk given just before going to rest.

There is abundant clinical evidence to show that the use of sugar[2] is closely connected with the amount of caries. The use of sugar as a food-stuff has increased enormously during recent years, and this food, it must be remembered, is readily soluble.

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[1] "A Preliminary Note on the Nutritive Value of White and of Standard Bread," *Brit. Med. Journ.*, May 6, 1911.

[2] Sugar reached England about the beginning of the twelfth century, but it was only a luxury indulged in by the well-to-do classes. At the beginning of the eighteenth century the average amount per head imported was 3 lb.; at the beginning of the nineteenth century, 22 lb.; in 1905 the amount had

The harmful effect of sugar on the teeth is referred to by Berdmore[1] in these words: "I am credibly informed that in the Low Countries where sugar, tea and coffee and sweetmeats are used in excess, the people even at an early age are remarkable for the badness of their teeth. It is, therefore, advisable to eat of them but seldom, and always to wash the teeth after them." Heutzer, the German traveller, noticed that the teeth of Queen Elizabeth "were black, a defect the English seem subject to from their too great use of sugar."

The result of S. Colyer's[2] observations of certain African tribes supports the view that fermentable sugars are an important factor in the production of dental caries:—

(1) The Barotze, a people living on either side of the Upper Zambesi, have as their chief food cassava and mealies. Cassava is a shrub with large tuberous roots, which, after soaking and drying, is pounded into a fine white powder, possessing a large, but very finely divided, fibrous constituent. It is prepared for eating by sprinkling the powder with water which has been just brought to the boil and then stirring with a stick, the resultant mixture being an elastic and rather sticky mass. Mealies are also prepared as a thick glutinous mass. The food requires very little mastication and tends to cling about the teeth, which are not cleaned after meals. Now, amongst the Barotze caries is uncommon, while marginal gingivitis and periodontal disease are extremely common. The caries which does occur progresses slowly, and seldom if ever starts on the approximal surfaces of the teeth.

(2) Amongst the natives living near or upon the Lakes Mweru and Bangweulu, whose staple food is red millet, periodontal disease is very common, but caries is even less common than in the Barotze, only one tooth in 270 being carious. The comparative freedom from caries in these two groups, S. Colyer remarks, cannot be due to the self-cleasing action of the foods, for they are soft and sticky; nor can the immunity from caries be attributed to the

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risen to 74·45 lb., and in 1911 to 92·05 lb. In 1911, 6·31 lb. per head of glucose was consumed in addition to the imported sugar. These figures show that the use of sugar as a food-stuff has greatly increased during recent years.

[1] "A treatise on the Disorders and Deformities of the Teeth and Gums," Thomas Berdmore.

[2] *Dental Record,* vol. xxxvi, No. 1; vol. xxxvii, No. 9; vol. xxxix, No. 11.

absence of carbohydrates, for the foods eaten contain a high percentage of this element; cassava about 20 per cent., maize and millet about 70 per cent. These food-stuffs, however, do lack the presence of easily fermentable carbohydrates in the form of the various sugars.

(3) In the Transkeian territories the staple foods are mealies and Kaffir corn, but in addition a considerable quantity of sugar is eaten; the sugar is mixed with the porridge, is sometimes taken raw, and two, or at times three, teaspoonfuls are added to each cup of tea or coffee consumed. Mothers give sugar to their children by day and sometimes at night to pacify them. Amongst these natives, caries of the teeth is common, the interstitial surfaces being frequently attacked. Natives are seen with dentures completely ruined by caries. Caries of the incisors is common, and the young are as frequently affected as their elders. Periodontal disease, on the other hand, is comparatively rare.

In a paper by L. Ottofy on "The Teeth of the Igorots,"[1] the relation of sugars to caries is well brought out. In the Igorots of the Philippines, a semi-barbaric race, he found only 2·05 per cent. of carious teeth; while in the Filipinos, the more civilized inhabitants of the islands, the amount of caries was 20·9 per cent. The diet of the Igorots consists of food requiring considerable mastication; bread is unknown and sugar is distasteful to the children. The Filipinos, on the other hand, indulge freely in the practice of chewing sugar, which is sold in small pieces all over the islands, and Ottofy is convinced that the prevalence of caries in the Filipinos is due to sugar. There is abundant clinical evidence to show that the use of sugar is closely connected with the amount of caries. In practice it is found that children who eat sweets in large quantities will return from school each term with a plentiful supply of fresh and generally rapid caries, but when the eating of sweets is stopped the amount of fresh caries rapidly declines.

In the County of Shropshire an inquiry was carried out to ascertain the relation of "sweets" to caries, the term "sweets" being used in the popular sense and not including sugary foods taken at meal times. The classification adopted was:—

Class 1. Large quantities of sweets eaten—almost every day.
Class 2. Considerable quantities eaten—several times a week.
Class 3. Few sweets eaten—about once a week.
Class 4. No sweets at all eaten.

In all 5,856 children were examined, and it was found that caries predominated where sweets were eaten in large quantities, and that as the consumption of sweets diminished the number of carious teeth decreased and the number of sound dentures increased.

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[1] *Dental Cosmos*, July, 1908.

Under the nomenclature of " comforter caries " E. H. Harries[1] drew attention to a rapid destruction of the maxillary incisors in infants, the teeth becoming affected soon after their eruption. In some of the cases thickening of the upper lip was noted. All cases were associated with persistent use of the comforter. In cases which have come under my observation the comforter has usually been coated with a sweet substance, and it would seem therefore that in these cases the caries is not due to the action of the comforter itself but to the fermentation of the sugary substances used to cover the comforter.

Recapitulation.—The process of caries may be concisely described as follows: The form and relative positions of the human teeth favour the lodgment of food-stuffs in solid form or in solution upon or between the teeth. Of the three groups of food-stuffs—nitrogenous food, the carbohydrates, and fats—the second group is particularly concerned in bringing about the process of caries.

Of the three groups of carbohydrates—cellulose, starch and sugar—it is doubtful whether the first (cellulose) undergoes any change in the mouth which gives rise to products injurious to the teeth; whereas starch is first converted into dextrose by the action of the ptyalin of the saliva, and the dextrose, through the agency of micro-organisms (fermentation) into lactic acid, and possibly other organic acids in minute quantities. The sugars, when directly fermentable, are by the same process converted into acids, whereas those not directly fermentable, such as cane-sugar, take up a molecule of water under the action of invertin (a ferment produced by many bacteria), and are then split up into dextrose and levulose, both of which are directly fermentable, and produce lactic acid in the presence of many mouth bacteria.

These acids, from whatever source produced, attack the teeth at the point where they are generated, that is, wherever the foods in solid or fluid form have lodged on or between the teeth, and lead to decalcification, first of the enamel (or cement), and later of the dentine. The decalcification of the enamel results in its complete destruction, as the organic substance in the enamel is insufficient to hold together after decalcification, whereas decalcification of the dentine does not imply the complete destruction of the organic basis, as this remains in the form of the so-called tooth cartilage. As this organic basis is of a nitrogenous nature it undergoes decomposition in very much the same way as all other nitrogenous substances exposed to the action of bacteria in the presence of moisture and a suitable temperature. The agent which brings about this decomposition is a ferment produced by many of the bacteria of the mouth and acts in very much the same way as the pepsin of the gastric juice, except that it does not require the presence of acid. Very little is known as to what changes of a fermentative nature take place in the fats in the mouth. It is possible that a fermentation leading to the formation of fatty acids may occur, but if that is the case the quantity produced is so minute that it has not as yet been detected.

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[1] *Lancet,* November 11, 1911, p. 1327.

Nitrogenous substances, as explained above, undergo very active decomposition in the mouth, resulting, however, not in an acid, but in an alkaline reaction; an excess of nitrogenous food—for example, a diet consisting chiefly of meat—might serve to arrest the process of decay, inasmuch as the acids produced in the mouth by the fermentations or carbohydrates would be in part, or completely, neutralized by the alkaline products arising from the fermentation of nitrogenous food.

A consideration of the question of etiology would seem to suggest that the prevalence of caries in modern races is due to the soft character of the food, and the increase in the use of carbohydrates, which undergo rapid fermentation.

(H) SYMPTOMS

Pain in the region of the affected tooth may occur. If the caries is on a surface free to the tongue, the patient will be conscious of a cavity. In many instances, the lodgment of food between the teeth is the first symptom noticed. The pain is due to irritation of the fine termination of the nerves in the dentinal tubules, and will vary according to the situation and extent of the cavity. On occluding surfaces, the fibrils being exposed, changes of temperature or the introduction of irritant substances into the cavity will produce pain which increases in severity as the cavity becomes larger. In cavities tucked away under the gum or on approximal surfaces, pain is often not felt until the pulp is involved. The degree of pain varies with different temperaments, and in the same individual at different periods. Individuals of a nervous temperament suffer more than those of a lymphatic temperament. In a few individuals, caries gives rise to no pain.

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CHAPTER XII

The Treatment of Caries

Prophylactic Treatment—Remedial Treatment—The Preparation of Cavities—Hypersensitive Dentine—The Materials used for Filling Teeth—The Operation of Excision—The Use of Drugs in the Treatment of Caries—The Operation of Crowning

THE treatment of caries may be divided into
(A) Prophylactic.
(B) Remedial.

(A) PROPHYLACTIC

Rational treatment of caries, like the rational treatment of any other disease, must depend upon knowledge of the etiology of the disease. When a disease can be traced to its source its eradication can generally be quickly accomplished by the adoption of energetic preventive measures, and as an excellent example the stamping out of Malta fever may be quoted. For years this severe and dangerous complaint played havoc with our naval and military forces stationed at Malta and other parts of the Mediterranean, and, indeed, in many other parts of the world. The study of this disease was approached by experimental methods in 1887, and the knowledge thus gained, combined with scientific reasoning, resulted in the infection being traced to its source, namely, the milk of goats. With the banishment of goat's milk from the dietary, the fever has become practically extinct in the Army and the Navy.

Although, during recent years, advances have been made in our knowledge of the etiology of dental caries, we cannot yet claim that the true cause of the disease is known.

In discussing the cause of caries, attention was drawn to certain matters which appear to have a special bearing on the increase of caries, namely, the feeding in infancy, and the character of the food-stuffs, &c. A consideration of these matters seems to indicate that preventive treatment should be based somewhat on the following lines:—

The insistence on

(*a*) Breast-feeding whenever practicable.

(*b*) A diet during the early years of life which requires efficient mastication.

(*c*) The use of carbohydrates which are not easily fermentable.

With regard to *breast-feeding*, it is true that this natural function cannot always be performed. Too often, however, hand-feeding is substituted, not so much from inability of the mother as from an unnatural desire on the part of the mother to escape the ties which the duty of breast-feeding involves. When breast-feeding is impracticable, every care should be taken to ensure that the hand-feeding is carried out in a proper manner, and it is satisfactory to find that a great advance in this direction has been made in recent years.

The use of *food-stuffs* which require some effort in mastication is important, and "pap" food should, as far as possible, be carefully avoided. A very little experience of children will bring home the importance of this point. Bread soaked in milk is bolted, while bread given in the shape of a crust or a piece of toast is chewed, simply because the chewing is physiologically necessary. For similar reasons, meat, when given, should be cut in strips and not minced. Mastication promotes a healthy flow of saliva, and the saliva assists in cleansing the teeth.

There is little doubt that of the carbohydrate foods, the sugars are the most harmful, especially when taken between meals. *"Sweets" as popularly understood should be forbidden.* As carbohydrates are now known to be the source from which the lactic acid is derived, it is advisable so to arrange a meal that the last food-stuff taken is neither a sugar nor a starch. A meal should, if possible, finish with fruit or cheese. Fruit is especially beneficial, as it is slightly acid and stimulates the saliva. Meals should be given at regular intervals. If the salivary secretion is constantly being stimulated by incessant "nibbling" at food, it is probably robbed of its physiological properties and the supply required for the regular meals is depleted and probably altered in character.

A functional mouth is essential if caries is to be prevented. There are two important factors militating against a functional mouth: one is mouth-breathing and the other the presence of tender teeth. Mouth-breathing, as explained on p. 573, leads to a persistent marginal gingivitis which aids the retention of food around the teeth. It is very important therefore that any condition causing nasal obstruction should be removed in order to induce correct breathing. Tender teeth hinder mastication, and without proper mastication the natural cleaning of the teeth is interfered with. The mouth, then, must be freed of all tender teeth, either by filling or extraction.

The proper cleansing of the teeth after meals is a most important prophylactic measure, but this must be regarded as secondary in importance to the measures just referred to. The teeth should if possible be cleaned after every meal, but cleaning is specially needful after the last meal of the day. The tooth-brush should be small and contain fewer bristles than the brushes usually sold; the bristles should be of different lengths, so as to permit of their passing more easily into the interstices of the teeth. The following instructions for cleaning the teeth are issued to the patients at the Royal Dental Hospital of London:—

(1) The teeth **must** be kept clean.

(2) Use a small tooth-brush with stiff bristles. Use a little soap and some precipitated chalk.

(3) Brush all the teeth thoroughly, especially the back ones. Brush all surfaces of the teeth.

(4) Rinse the mouth thoroughly with clean water.

(5) Clean the teeth immediately **before going to bed.** Take no food of any sort afterwards. Clean the teeth again in the morning.

(6) **Clean teeth do not decay.**

With the eruption of the permanent incisors, the spaces between the teeth should be regularly cleared with silk.

In mouths, **where caries is progressing rapidly,** it is a useful measure to swab the mouth with an alkali the last thing before going to rest, for example:—

Mag. carb. levis	ʒiv.
Aq. rosæ	℥vj.
Aquam ... ... ad	℥xij.

Misce. Shake before using.

After cleansing the teeth, a tablespoonful of the above should be taken into the mouth and sluiced between the teeth.

In cases of acute fevers, or any other condition causing helplessness, the patient's teeth should be cleaned by the attendants.

Patients wearing dentures should be warned of the danger of neglecting to cleanse both the mouth and the dentures, especially where there are bands or clasps. Dentures cause caries only in so far as they assist in retaining food around the teeth.

In mouths showing a tendency to approximal caries of the anterior teeth, isolation should be obtained by the removal of the first or second premolars or the first molars (see p. 233). Isolation of the incisors and canines is a most valuable method of preventing caries between these teeth.

(B) REMEDIAL

The remedial treatment may be considered under the following headings:—

(1) The operation of filling.
(2) The operation of excision.
(3) The use of drugs.
(4) The adaptation of artificial crowns.
(5) The operation of extraction.

(1) THE OPERATION OF FILLING

(*a*) The Preparation of Cavities

It is not intended to describe fully all the various types of cavities and methods of inserting fillings which occur in practice; attention can be directed only to the more salient and elementary points. The manipulative skill required for correctly filling teeth can only be acquired by practice.

(i) General Points.—Success in filling depends largely upon a careful preparation of the cavities. The cavity in the tooth should first be freely opened up by means of fissure burs and enamel chisels and *all* the carious dentine removed. In the *retentive shaping*, care must be taken to avoid injury to the pulp and needless sacrifice of tooth substance which might endanger the stability of the cavity walls. *The simplest mode of shaping is to cut the cavity so that some part of the interior is a little larger in diameter than the diameter of the orifice.* In cavities with all the walls standing, this may be effected by making the walls slightly divergent from the orifice inwards. With cavities not possessing four walls, retention is usually obtained by means of *grooves*. The grooves must not be too deep; a deep groove is difficult to fill, and is a source of weakness. The grooves must be cut in the dentine, and in a direction parallel with the pulp. A frail margin of enamel should not be allowed to remain at the cervical portion of the cavity. For example, in fig. 509 the margin of enamel is frail, and liable to fracture during filling. The cavity should be extended so as to remove all the enamel.

The extension of cavities beyond the actual limit of the caries is often advisable in order to remove possible sources of failure and obtain "*self-cleansing*" *edges*. If there are two or more cavities in a tooth and there is little intervening tissue between them, the intervening tissue should be removed. Examples: On the occluding surface of a maxillary molar, cavities frequently exist in the anterior and posterior sulci, and if only a thin stretch of tissue remains when the cavities are prepared (fig. 510), it is better to unite them. With cavities in the approximal surfaces (see fig. 511) the intervening tooth structure should be removed, otherwise fracture is certain to occur from the force of mastication. With cavities on the occluding surface of the premolars and molars the fissures should be freely cut out.

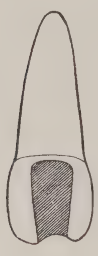


FIG. 509.

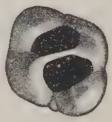


FIG. 510.

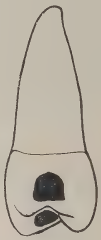


FIG. 511.

When the wall of a cavity is in close proximity to a fissure (fig. 512), the cavity should be extended so as to include the fissure (fig. 513). The extension of cavities so as to ensure "self-cleansing" edges is most desirable. All joints between fillings and tooth substance should be made as accessible as possible to the tongue and tooth-brush, in order that food may be prevented, as far as possible, from lodging near them. It is also most desirable that *fillings should be in contact with the approximal teeth* to prevent injury to the muco-periosteum during mastication (figs. 514 and 515).

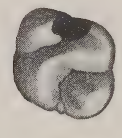


FIG. 512.

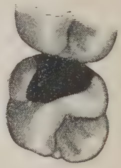


FIG. 513.

The Treatment of the Enamel Margins.—The best results are obtained by keeping the margin at right angles to the teeth on all surfaces except occluding surfaces (fig. 516). If the edges on occluding surfaces are left much undercut, a few enamel fibres will be unsupported by dentine—the fibres always run at right angles to the external surface of the enamel at that position—and the result will be that, with pressure, they will give way and form a vulnerable point in the filling (fig. 517 (*a*)). If, however, the margin is left only slightly bevelled, all the enamel fibres will be supported by dentine and a source of failure will have been removed (fig. 517 (*b*)).

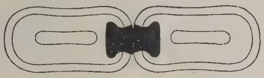


Fig. 514.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel cannot easily be kept clean.

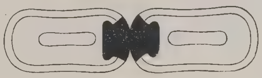
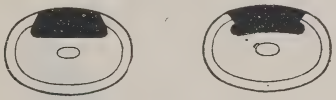


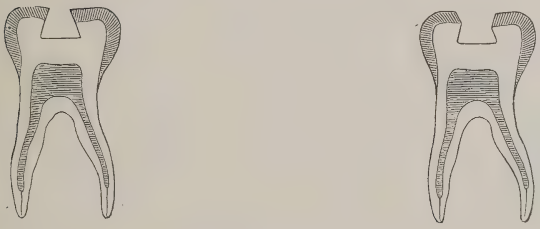
Fig. 515.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel can easily be kept clean.



(*a*)
Enamel margins incorrectly prepared.

(*b*)
Enamel margins correctly prepared.

Fig. 516.



(*a*)
Showing how not to leave the margins of enamel.

(*b*)
Showing how the enamel margin should be prepared.

Fig. 517.

The best instruments for carrying out this part of the work are fine-cut cavity burs and stones.

(ii) Relation of the Pulp Canals to the Surfaces of the Teeth. —Maxillary Teeth.

(*a*) *Incisors.*—The pulp of the *first incisor* follows to a great extent the contour of the tooth. It is prolonged towards the mesial and distal angles (fig. 518); care must therefore be taken to avoid cutting deeply in this part of the tooth. A section of the tooth near the neck shows that the pulp lies a little nearer to the labial than to the palatal aspect of the tooth; pits and grooves can therefore be made with greater safety in the palatal part of the tooth. Access to the pulp canal should be gained through the palatal aspect, the opening being made below the pit (fig. 519) and not through it. An opening made through the pit will meet the canal at an angle. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal. The direction in which an approximal cavity should be extended to open the pulp canal is shown in fig. 520.

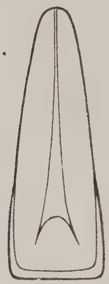


Fig. 518.

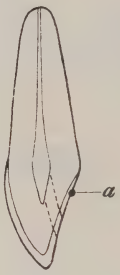


Fig. 519.

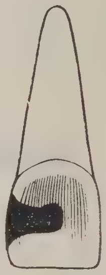


Fig. 520.

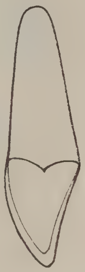


Fig. 521.

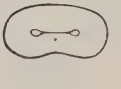


Fig. 522.

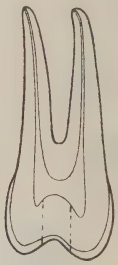


Fig. 523.—Showing method of opening into the pulp canals of a first premolar from the occluding surface.

The enamel on the approximal surfaces ends as shown in fig. 521. This fact must be taken into consideration when preparing the cervical portion of the cavity.

The pulp of the *second incisor* is practically similar in shape to that of the first incisor, but it is larger in proportion to the size of the tooth and is therefore more often exposed.

(*b*) *Canine.*—The pulp is not prolonged towards the mesial and distal angles as in the incisors. In comparison with the incisors, the pulp is relatively small. Access to the pulp canal should be gained through the palatal aspect of the tooth. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal.

(*c*) *Premolars.*—In the *first premolars* there are usually two canals. The pulp is constricted at the neck (see fig. 522). In extending cavities to the pulp canal, it is almost always necessary to cut towards the cusps, as shown in fig. 523.

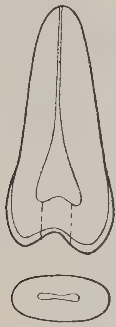


FIG. 524.

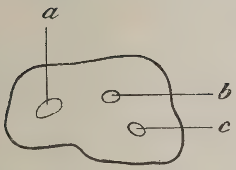


FIG. 525.—First molar : (*a*) palatine root; (*b*) posterior buccal root; (*c*) anterior buccal root.

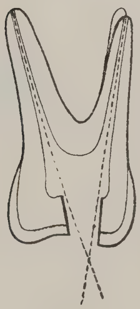


FIG. 526.

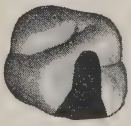


FIG. 527.

The *second premolar* usually has one root canal. The pulp is not so constricted at the neck as it is in the first premolar. Access to the pulp canal is gained in the same manner as with the first premolar (see fig. 524).

(*d*) *Molars.*—The *first molar* has three roots.—On the anterior aspect the pulp is nearer the surface than on the posterior aspect—

a point to be remembered in extending cavities. The relative position of the orifices of the canals is shown in fig. 525. The direction of the axes of the pulp canals towards the occluding surface is seen in fig. 526. Access to the canals is gained by extending the cavities towards the buccal surface (see fig. 527). By this means, direct access to the buccal and palatine roots can be obtained.

The *second molar* has three roots. Its palatine root is more in line with the longitudinal axis of the tooth than is the case with the palatine root of the first molar, and for this reason access to the canals should be gained by extending the cavities towards the centre of the occluding surface rather than towards the buccal aspect. The pulp, as in the first molar, is situated nearer to the anterior than to the posterior aspect of the tooth.

Mandibular Teeth.

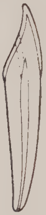


Fig. 528.—Showing method of approaching the pulp canal of a mandibular incisor.

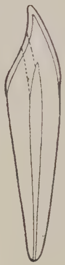


Fig. 529.—Showing method of approaching the pulp canal of a mandibular canine.

(*a*) *Incisors and Canines.*—Access to the pulp chambers should be gained by an opening on the lingual surface, the opening being made well towards the incisive margin (figs. 528 and 529).

(*b*) *Premolars.*—The crown of the *first premolar* is slightly bent on the root, the inclination being towards the tongue. A section of this tooth shows that direct access to the pulp canal is best gained by drilling through the lingual aspect of the buccal cusp (see fig. 530). In extending approximal cavities to the pulp canals the operation should be carried out as shown in fig. 531. Extension of the cavity through the coronal fissure—the method commonly adopted—will strike the pulp canal at an angle, while extension as advised will give direct access to the canal.

With the *second premolar*, the inclination of the crown towards the tongue is not so marked and extension to the pulp canal should therefore be made by cutting rather more towards the coronal fissure (see figs. 532 and 533).

(*c*) *Molars.*—The *first molar* has two roots. The canal in the anterior root is much constricted in the centre, while the pulp canal in the posterior root is well marked. Access to the pulp canals should be gained by extending the cavity towards the central portion of the occluding surface.

The *second molar* has two roots. The pulp canal in the anterior root is not, as a rule, constricted as in the first molar. Access to the canal is gained in a manner similar to that pursued with the first molar.

(iii) Simple Cavities.—The simplest form of cavity is that in which all the walls are complete, and good examples are the cavities occurring upon the crowns of molars and premolars. In shaping these cavities, the walls should be made slightly out of the perpendicular, the floor being left flat and the edges trimmed as directed. All fissures on the occluding surface must be freely cut out.

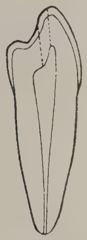


FIG. 530.

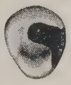


FIG. 531.

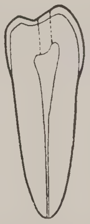


FIG. 532.

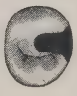
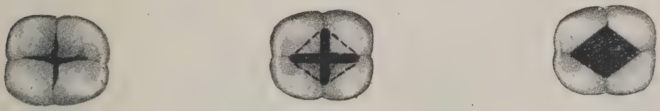


FIG. 533.



(*a*) Showing tooth before preparation.

(*b*) The dotted lines show the portion of enamel to be removed by the enamel chisel.

(*c*) Cavity prepared. Note: the margins should be left a little more rounded than shown in diagram.

FIG. 534.

In the preparation of simple cavities the *modus operandi* is as follows: Example: Carious mandibular second molar (fig. 534). With a fissure bur a cut is made through all the fissures (see fig. 534 (*a*)). An enamel chisel is then used to break down any triangular pieces of enamel thus left (fig. 534 (*b*)). The carious dentine is then removed with suitable instruments and the walls correctly shaped (fig. 534 (*c*)).

For simple cavities on the labial, buccal and lingual surfaces, the rules as to simple crown cavities apply. For cavities on the incisive margin of the anterior teeth, a slight undercut should be made throughout the breadth of the cavity. The edges must be prepared in such a way that the filling, when inserted, completely covers them, otherwise failure through fracture of the enamel margins is liable to occur (figs. 535 and 536).

(iv) Approximal Cavities.—In the case of cavities on the approximal surface (fig. 537) of the *molars and premolars* access must be gained through the occluding surface. The cutting is performed with a small fissure bur, the cut being taken well back on the coronal aspect. The weak edges of enamel (see dotted line, fig. 538) are then broken down. The carious dentine is next cleared away. The cavity then to be dealt with is somewhat cup-shaped (fig. 539). In shaping the cavity it must be remembered that the filling has to be prevented from coming out in two directions, viz., from above downwards and laterally. The labial and lingual walls (*a* and *b*) should therefore be cut so as to diverge not only towards

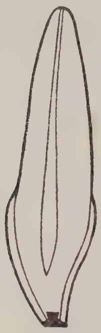


FIG. 535.—Cavity involving cutting edge of first incisor. Transverse section showing method of preparing cavity.

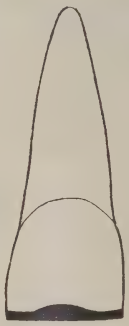


FIG. 536.—Showing cavity filled.

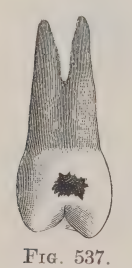


FIG. 537.

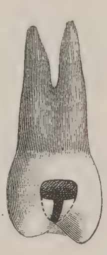


FIG. 538.

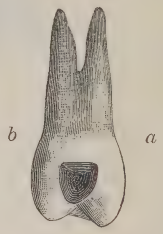


FIG. 539.

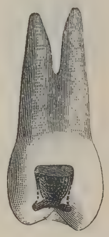


FIG. 540.

the cervical margin, but also towards the axial portion of the tooth. To carry out this step two grooves are made which diverge as they approach the cervical margin (fig. 540). The portion of tissue shown by the dotted lines is then removed, and a double wedge-shaped cavity is obtained.

Should the fissure in the coronal surface be carious, it must be cut out, but, in the case of premolars, special care should be taken to remove as little tissue as possible. The inner cusp of a premolar is liable to fracture if large cavities are present on both anterior and posterior surfaces and the retention of an isthmus of dentine between the outer and inner cusps considerably increases the stability of the tooth. It is also a good plan to cut away the inner cusp and extend the filling over it. When cohesive gold is used to fill approximal cavities, the filling is started by wedging a piece of gold into a pit or groove, a groove being generally preferred. The groove, small and slightly undercut, is made in the cervical wall of the cavity. For a few cavities the older method of "*starting pits*" will be found useful. These pits are made as follows: The drill is buried so that the head is just below the level of that part of the cavity where the pit is to be made, and the head is then moved with a slight circular motion; the result is a small cavity (fig. 541). If the drill head is only half buried, a cup-shaped cavity will be produced, and this is useless (fig. 542). A starting pit should always be drilled in the dentine itself. If it is drilled at the junction of the enamel and dentine, one wall will be formed of enamel, and this leads to fracture during filling. Starting pits should be situated as far away from the pulp as possible.

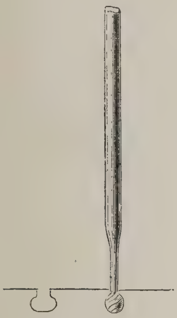


FIG. 541.

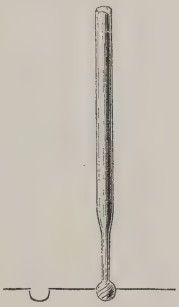


FIG. 542.

The advantage of shaping approximal cavities like a double wedge when cohesive gold is used is that all parts are easily accessible and filling is thus more satisfactorily carried out.

Small approximal cavities in molars and premolars situated near the gum may be approached from the labial or buccal walls (fig. 543); an opening from the crown entails the loss of much sound tissue. The retentive shaping of the cavity is carried out as described above. The lingual wall forms the base of these cavities. This method of treating approximal cavities is adopted when the caries is situated in the root of the tooth.

Of approximal cavities in the anterior teeth the smallest are often the most difficult to fill. A good separation of the teeth is needful.

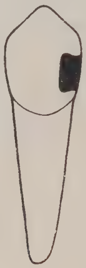


FIG. 543.—Showing approximal cavity in a mandibular premolar opened up from the labial wall.

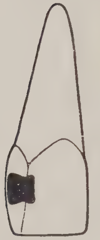


FIG. 544.

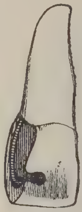


FIG. 545.[1]

In small cavities for which non-cohesive gold is intended, the preparation is similar to that for simple cavities—namely, walls slightly divergent. For cohesive gold, small cavities are to be prepared as follows: With a fine finishing bur the anterior wall is cut so that it slopes outwards and can be easily seen, a starting pit being made at the cervical margin, and an opposing point below for retention of the filling. With larger cavities an approach should be made from the lingual aspect, the labial wall being saved as much as possible. The shaping of the cavity will then be somewhat like that of approximal cavities in premolars and molars, retention being obtained by a slight groove in the cervical wall, opposed by a small groove or pit, according to the amount of tissue available (fig. 544).

---

[1] From Kirk's "Operative Dentistry."

When the cavity involves a large portion of the side of the tooth, the labial and lingual walls must both be freed from all frail enamel and a different mode of procedure adopted in shaping it. *The labial and lingual walls should not be grooved.* In the cervical wall a groove should be made, and opposed by a good-sized pit drilled towards the apex of the cavity. In many cases, the occlusal portion of the cavity cannot with safety support an anchorage, but if the cavity is extended in the manner shown in fig. 545 an excellent hold will be obtained.

The *preparation of cavities for plastic fillings* differs slightly from the preparation of cavities for gold. The enamel margins on the occluding surface should be straight and not bevelled, as the thin layer of enamel thus left is less likely to fracture than the feather edge of plastic material.

(*b*) Hypersensitive Dentine

The preparation of cavities for filling is at times hampered by hypersensitive dentine. The area of hypersensitiveness frequently varies, one portion of the tooth being distinctly more painful than another. The portions of dentine immediately beneath the enamel and at the neck of the tooth are usually the most sensitive.

The pain can be greatly alleviated by keeping the cavity dry during excavation, and by using sharp instruments with a decided cutting and not scraping action.

Treatment:—

Dehydration.—The application of hot air in the form of blasts from a suitable syringe greatly reduces the sensitiveness. The hot air may cause a little pain, but if it is applied with tact and care pain can usually be avoided. The hot air dehydrates the dentine. If absolute alcohol is applied before the hot air, the dehydration is increased, but the treatment is more painful.

The Local Application of Drugs.—Strong carbolic acid allowed to remain in the cavity for a few minutes and the dentine dried with hot air. This remedy is not very efficient if immediate relief is desired, but if carbolic acid is sealed in the cavity for two or three days a decided obtunding of the dentine is obtained.

Chloride of zinc is a useful drug, but it must be used with caution when the pulp is near. The cavity must be isolated and a small piece of chloride of zinc in the solid state allowed to dissolve. The application causes pain, but the pain rapidly passes away.

Nitrate of silver causes unsightly discoloration and can only be applied to the posterior teeth. It is slow in its action. In superficial cavities, the nitrate of silver is applied in the form of a fine powder on a piece of cotton-wool slightly moistened, or the drug in a solid state may be rubbed over the sensitive surface. The tooth is then left for one or two days, when the dentine becomes less sensitive. In deeper cavities, a little of the fine powder may be sealed in with gutta-percha.

Where it is intended to use metal fillings and the dentine is sensitive, the best course is to insert an oxy-phosphate filling and allow it to remain for about six months. In some instances, the tooth substance is so sensitive that it is almost impossible to remove any of the carious tissue. A filling of oxy-sulphate of zinc, if left in place for one or two weeks, will allay the sensitiveness sufficiently to allow of the preparation of the cavity. For posterior teeth which are very sensitive, the application of nitrate of silver may be substituted for the oxy-sulphate.

Preparations containing formalin give good results, but they must be used with care, as formalin possesses great power of penetration and may endanger the vitality of the pulp.

Local Anæsthesia.—In cases where the teeth are extremely sensitive and the local application of drugs fails to relieve the pain, local anæsthesia should be produced by the use of novocain (see Chapter XXXVI). The tissues may also be rendered insensitive by the use of freezing agents. Considerable attention has recently been directed to this method by the introduction of an apparatus designed to lower the temperature and so avoid the pain which usually accompanies the first application of the drug.

(*c*) The Materials used for filling Teeth

The materials used for filling teeth are gold, amalgam, osteoplastics, synthetic cements, gutta-percha, and porcelain. Solutions of gum resins are employed in conjunction with cotton-wool as temporary fillings. *An ideal filling* should be hard enough to resist attrition; capable of withstanding any chemical action of the mouth; a non-irritant; a non-conductor and easy of adaptation; it should retain its shape after insertion and, in colour, should resemble the natural tooth. At present no filling in general use fulfils all these conditions, and for any given case a selection has to be made from the most suitable materials available.

(i) Gold.—Two forms are used, viz., *the cohesive and the non-cohesive preparations.*

In the cohesive method, each piece of gold is made to cohere to that already in place, and should not move in the slightest degree after it has once been placed in position. *In the non-cohesive method*, the portions of the filling are held together by being closely interlaced and wedged against each other. Those who favour non-cohesive gold claim that it adapts itself to the walls of the cavity better than cohesive gold, and can be worked quicker; while those who favour cohesive gold assert that, although it takes longer to work, it makes a harder filling; adapts itself to the cavity walls quite as well as non-cohesive gold, provided that the cavity is properly prepared, and, for approximal cavities, possesses the additional advantage of being able to withstand the force of mastication.

Generally it may be said that non-cohesive gold is better for crown cavities and the cervical one-third of approximal cavities in molars, premolars and anterior teeth, and that cohesive gold is more serviceable when any contouring is necessary or any strain is likely to be thrown upon the filling.

In recent years gold as a filling material has been largely superseded by amalgam for the posterior teeth and by synthetic cements for the anterior teeth. The substitution of amalgam for gold for the posterior teeth has been brought about by the improvements made in the construction of amalgam, an amalgam filling now being almost as efficient as a gold filling. Amalgam also possesses a distinct advantage in being more easily contoured than gold, and, in finishing, there is less likelihood of injuring the soft tissues at the neck of the tooth—a point of considerable importance in relation to periodontal disease. Synthetic cements for the anterior teeth have supplanted gold for æsthetic reasons, but they are not so reliable as gold.

The advantages of gold as a filling are (*a*) that it retains its shape, and constitutes practically a water-tight plug, and (*b*) that it withstands attrition. In using gold it should be remembered that it has no preservative action whatever upon the tooth substance.

(ii) Plastic Fillings.

(*a*) **Amalgam.**—An amalgam is an alloy of which one constituent is mercury. The amalgams used in dental practice consist of the combination of the mercury with a single metal, as in palladium, copper and silver amalgams, or with alloys of two or more metals. Amalgam has a much greater range of usefulness than any other filling, but it possesses two important disadvantages, viz.:—

(*a*) Liability to become discoloured—principally through the formation of sulphides from the action of sulphuretted hydrogen in the mouth.

(*b*) Tendency to alter its shape and to fracture at the edges.

Both these drawbacks may be overcome to some extent by:—

(i) Special attention to the composition and manufacture of the alloy.

(ii) Attention to the preparation of the cavity.

(iii) The method of inserting the filling.

Viewed by the light of present knowledge, it appears that the basis of the alloy should be composed of silver and tin, with the addition of gold and zinc or copper when the amalgam is not to be used in a position likely to be seen. In addition, it is important that the utmost care be taken in casting, cutting and annealing the alloy.

The following is the formula of a good working amalgam[1]:—

Silver	69·5	parts.
Tin	25·5	,,
Gold	4·0	,,
Zinc	1·0	,,

The preparation of cavities for amalgam fillings differs only slightly from that required for gold fillings. Amalgam being a plastic material which will mould itself into the inner recesses, it is not so important that there should be direct access to all parts of the cavity. The edges should be left straight, and not bevelled, as the thin layer of enamel is less liable to fracture than the thin ledge of amalgam which would be present if the edges were bevelled. The student must remember that the preparation of cavities for the insertion of amalgam fillings requires as much care and attention as the preparation of cavities for gold fillings.

Galvanic Action from Amalgam Fillings.—The occlusion of teeth containing amalgam and gold fillings will start galvanic action under certain conditions.

The following are examples from practice: An amalgam filling was inserted in a left second molar which occluded with a gold crown. Two days afterwards the patient complained of distinct pain whenever the amalgam and crown were brought into contact, and expressed the opinion that the pain was due to electrical action. The whole of the surface of the amalgam filling, which occluded with the gold, was cut out and filled with a non-conducting filling (oxy-phosphate), and the pain ceased. In another case a biting-block of gold occluded with an amalgam filling. The tooth was not painful to heat or cold, but pain was felt every time it was brought into contact with the gold biting-block.

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[1] For the various formulæ of fillings I am indebted to Andrew Kelly.

(β) **Osteoplastics.**

(i) *Oxy-chlorides.*—The powder consists of zinc oxide which has been heated almost to whiteness for about two hours, during which time it loses half its bulk. Borax and silica are often mixed with it with a view to increase its hardness. Oxide of zinc often contains arsenic as an impurity, but it is not probable that arsenic is ever present in sufficient quantity to exert any deleterious effect. The fluid is a solution of zinc chloride in water in proportion of four to three. Oxy-chloride of zinc does not form a permanent filling, as it is acted upon by fluids of the mouth, especially at the cervical margin. It is also of little use in places where there is much attrition. It is hygroscopic, sets quickly, is an irritant and an antiseptic. Oxy-chloride is principally employed as a root filling and as an obtundent for sensitive dentine.

(ii) *Oxy-phosphates.*—The powder is made of oxide of zinc. The oxides of magnesium and aluminium are sometimes added with the view of accelerating the setting. The various shades of colour are produced by colouring matters, which probably lessen the resistance of the filling to solvents. The fluid is principally composed of phosphoric acid, zinc oxide and water.

As a filling the oxy-phosphate is more permanent than the oxy-chloride. It is soluble in the alkaline secretions of the mouth. It is antiseptic, though not so marked as the chloride, and, like the latter, it may lead to death of the pulp if used in too close proximity to that organ. Oxy-phosphate fillings last, on the average, about two years, though they may continue serviceable for seven years, and in rare instances longer.

The use of oxy-phosphate is indicated—

(1) As a flooring in crown cavities (when not too near the pulp).

(2) As a root filling.

(3) As a lining to cavities with frail walls.

(4) In cavities which are sensitive, and in which it is desired to insert a metal filling—an oxy-phosphate filling allowed to remain for a period of three to six months will act as an obtundent.

(5) In front teeth of weak structure.

(6) In combination with amalgam.

(7) For the fixation of crowns and porcelain inlays.

It should not be used in cavities which cannot be kept absolutely free from moisture during filling.

(iii) *Oxy-sulphate.*—The powder is composed of a mixture of calcined sulphate of zinc and oxide of zinc. The fluid is a solution of gum arabic.

The following is a useful formula:—

Powder:	Zinc oxide ...	82 parts.	*Fluid:* 20 per cent. solution of gum acacia, to which a suitable preservative may be added.
	Zinc sulphate ...	11 ,,	
	Mastic	7 ,,	

Oxy-sulphate is extremely useful:—

(1) As a flooring to sensitive cavities near the pulp.

(2) For covering exposed pulps (in combination with a sedative).

(3) For very sensitive cavities. A filling of oxy-sulphate used for one or two weeks will allay the sensitiveness.

(iv) *Oxy-phosphate of copper* has been introduced by Ames, and is most valuable for the fixation of splints in the treatment of fractured jaws.

(γ) **Synthetic Cements.**—During the last few years synthetic or translucent cements have been extensively used as fillings.

Synthetic cements are not adhesive, and it is necessary therefore that the cavity should be cut to retain the filling as in the case of gold and amalgam. There is a tendency for the synthetic cement to cause death of the pulp, and it is advisable therefore that cavities should be lined with an oxy-phosphate or an oxy-sulphate cement. Their use is indicated for æsthetic purposes in cavities in the anterior teeth. They should not be used on occluding surfaces, or for the approximal cavities in premolars and molars, as in these places amalgams or gold are more serviceable and reliable.

(δ) **Gutta-percha.**—Gutta-percha is the inspissated juice of *Isonandra gutta* and other trees of the natural order *Sapotaceæ*, For dental purposes it is generally combined with zinc oxide and silica, with or without some colouring matter. The resins appear to lower the softening point, increase the time of setting, and considerably diminish the tensile strength.

Gutta-percha deteriorates from exposure to air and light, more especially the latter. The deterioration depends greatly upon the quality of the gutta-percha. A good gutta-percha filling should be tough, should soften at a temperature not more than 175° F., and should set in from thirty to forty-five minutes. It should be "sticky" in working. The filling material is best preserved in the form of sticks wrapped in tin-foil and kept in a box, pieces being cut off as required. The following formula is recommended by W. Rushton[1]:—

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[1] *Trans. Odonto. Soc.*, 1898, p. 120.

Pure gutta	50 parts.
Finely levigated silica	30 ,,
Oxide of zinc	20 ,,

The gutta should be gradually heated and the powders added in small quantities at a time.

The following is a useful type of temporary gutta-percha:—

Gutta-percha	18 parts.
Hard paraffin	9 ,,
Calcium sulphate	26 ,,
Oxide of zinc	47 ,,

Properties.—As a filling, gutta-percha is a perfect non-conductor, and, though it does not make a water-tight filling, fresh caries seldom seems to occur from this defect. In dirty mouths, it discolours, becoming yellowish in appearance. If inserted too near the pulp, it frequently leads to the destruction of that organ. Cavities in which gutta-percha is temporarily placed often appear to be more sensitive on the removal of that material than before its insertion, which seems to show that gutta-percha increases the sensitiveness of dentine.

Indications for Use.—Gutta-percha should not be used upon a masticating surface, as it bears attrition badly. Gutta-percha, though principally used as a temporary filling, is occasionally of great use permanently, the principal cases in which its use is indicated being:—

(1) The anterior teeth of young children, as the saliva in children seems to dissolve osteoplastics very quickly.

(2) In certain cavities on the buccal and labial surfaces of teeth.

(3) For filling root canals.

(4) As a temporary filling where it is necessary to wedge the teeth for the purpose of separation before the introduction of a permanent filling.

(ϵ) **The Solution of various Resins.**—Gum mastic and gum sandarac are used as temporary fillings. They harden through the resin being precipitated by the saliva and the evaporation of the solvent ether, chloroform, &c.

(ζ) **Porcelain Inlays.**—During the last few years, porcelain inlays as fillings have claimed a large amount of attention. They possess the advantage of more nearly resembling the appearance of the tooth than any other filling, and are therefore extremely useful for cavities on exposed surfaces. They are fixed in position with oxy-phosphate cement. In estimating the usefulness of this filling, it must be remembered that oxy-phosphate cement is acted upon by the saliva and that the layer of cement between the inlay and the tooth substance must be regarded as a vulnerable point. In durability, porcelain inlays are inferior to gold and amalgam, but they are superior to gutta-percha and osteoplastics. During recent years they have been almost entirely superseded by the synthetic cements.

(η) **Gold Inlays.**—Inlays made of cast gold are advocated by some operators for use in approximal and crown cavities in the posterior teeth, the inlays being fixed into position by means of oxy-phosphate cement. It is difficult to see that these inlays have any advantage over properly constructed amalgam fillings. With the latter, retention is obtained by means of undercuts—a much more reliable and rational method than by trusting to the adhesiveness of osteoplastics. With amalgam, good edges can be obtained and the filling more easily brought to the proper contour.

(2) THE OPERATION OF EXCISION

In the operation of excision, the diseased part is cut away and the surface polished. It is applicable in very few cases, the most suitable being the approximal surfaces of the molars and premolars when the caries is quite superficial and the surfaces are exposed.

(3) THE USE OF DRUGS

The progress of caries may be considerably retarded and sometimes arrested by the application of certain drugs, the most useful of which is nitrate of silver. Drugs can be employed with advantage for superficial caries of the cement.

The **nitrate of silver** is applied in the form of a saturated solution, or, still better, the solid drug is rubbed over the surface. Two or three applications, at intervals of about a week, will effect a considerable hardening of the surface. The nitrate of silver precipitates the albumin in the tubules and forms an albuminate of silver which is a powerful antiseptic. The discoloration produced is an objection to its use on the anterior teeth. In cases of general softening of the cement often seen in patients whose gums have receded, the application of nitrate of silver to the back teeth and **chloride of zinc** to the anterior teeth, with the regular use of **alcohol,** will retard and often arrest the condition. The alcohol should be used as follows:

The teeth are dried and absolute alcohol applied to the roots either on a brush or cotton-wool, the saliva being kept away for about two minutes. The alcohol precipitates the albumin in the tubes and, in evaporating, helps to dehydrate the dentine. The application should be made at least once a day. In the extensive caries at times seen in the deciduous teeth, the application of nitrate of silver every two or three months and the regular use of the alcohol will often arrest the caries and give the patient the use of a masticating surface—a point of the greatest importance.

(4) THE OPERATION OF CROWNING

The operation of crowning may be resorted to where the destruction of the crown by caries is so extensive as to prevent the introduction of reliable fillings.

Teeth or roots which are to be crowned must be rendered quite free from periodontitis, and the root canals made absolutely aseptic. The apex of the root canal should be filled before any reaming of the canal is carried out in order to prevent injury of the periodontal membrane by foreign matter.

There are many **varieties of crowns and methods of crowning.** Broadly, they fall under two headings: (1) crowns without collars, and (2) crowns with collars. Crowns with collars are fitted with a ring of metal which embraces the neck of the tooth to give additional stability to the crown. But the collar is liable to injure the margin of the periodontal membrane, destroy that tissue and create a stagnation area and, for this reason, collar crowns should never be used. Teeth that cannot be restored by contour amalgam fillings are not suitable for collar crowns, or indeed for any other type of crown. It is certainly possible to restore badly broken-down teeth to act as efficient masticating organs by means of collar crowns, but the gain to the masticating area is outweighed by the injury caused to the periodontal membrane and the creation of a focus of infection which must inevitably follow. Again, if teeth are present on one or both sides of the crowns, "spaces" are sure to form which will lead to injury of the approximal teeth and hasten their loss. It is far wiser to lose the masticating area which the crown would give and retain in health the periodontal membrane of the approximal teeth.

If it is considered necessary to crown a tooth, crowns without collars should be used in order that a "clean joint" may be obtained, the lodgment of débris prevented and the risk of injury to the periodontal membrane minimized.

(5) THE OPERATION OF EXTRACTION

In all cases of caries where one of the above methods cannot be employed the tooth should be removed. For the methods of extracting teeth, see Chapter XXVII.

CHAPTER XIII

Destruction of Teeth from Causes other than Caries: Abrasion. Attrition

In caries of the teeth, the tooth substance is gradually destroyed by the action of acids and micro-organisms. Progressive destruction of the tooth substance may, however, be caused by other agencies and of these the most important is abrasion.

(A) ABRASION

The term **abrasion** is used to denote the destruction of the tooth substance by friction with a foreign body, such as a denture, pipe, tooth-brush or tooth-powders. The action of a clasp on a denture produces a shallow depression, the surface of which usually presents an eburnated appearance. Friction on the tooth from the use of a clay pipe results in destruction of the occlusal portion of a tooth or teeth, a curve-shaped notch being formed.

The commonest cause of abrasion is the tooth-brush when used in combination with abrasive tooth-powders. With the gradual recession of the gum, the neck of the tooth becomes exposed, and the tooth-brush, if used transversely, will tend to produce V-shaped cavities in the dentine. Such cavities are mostly found upon the maxillary canines and the mandibular canines and first premolars—the teeth which form the prominent parts of the curves of the arch. Abrasion is often more marked upon the left than the right side, and this is no doubt due to the fact that when the tooth-brush is used with the right hand—the common practice—more force is naturally applied on the left side of the mouth.

Occasionally the destruction of the enamel surface may be caused by the use of the tooth-brush and give rise to the condition usually known as "erosion." In this type of abrasion the appearances of the teeth vary. The labial surfaces of the anterior teeth may be affected, in which case the condition may be limited to one tooth or may involve several. The earliest indication is a slight depression which gradually deepens and extends towards the incisive margin. Gradually a cup-shaped depression is formed, which is deepest towards the cervical margin and becomes shallower as the incisive edge is reached. Fig. 546 is an example of an advanced case. Sometimes the teeth look as if they had been pared down with a knife in a direction sloping from the labial to the lingual surfaces, and, when the mouth is closed, a considerable interval is left between the maxillary and mandibular teeth (fig. 547). To the naked eye, the teeth attacked appear hard and polished, with, occasionally, a darkish film on the surface. The dentine exposed is hypersensitive.

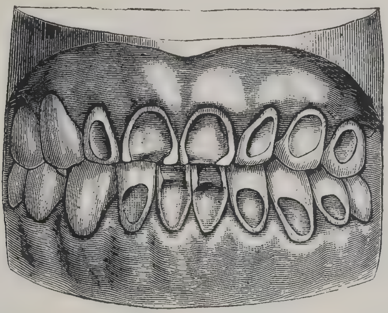

Fig. 546.[1]

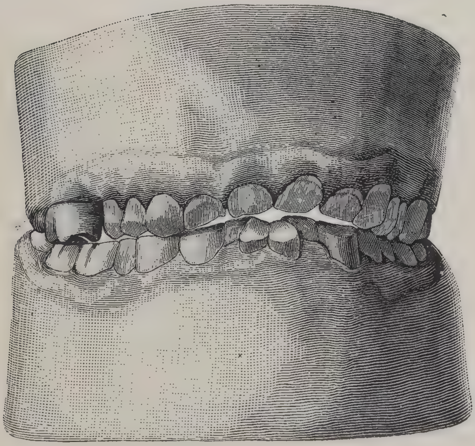

Fig. 547.

Sections of the dentine show the fibrils or tubes ending abruptly as if cut with some sharp instrument. The tooth substance adjacent to the eroded surface cannot be stained, and this point is worthy of attention.

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[1] From "The American System of Dental Surgery."

Changes in the Pulp.—In teeth showing abrasion, formative activity occurs in the pulp, and results in the formation of secondary dentine at the pulp end of the affected dentinal fibrils. If the abrasive process is rapid, the dentine may be destroyed more quickly than the protective dentine is formed, in which case the pulp becomes exposed and a septic inflammation occurs.

Experimental Investigation.—For many years the cause of the curious destruction of the tooth tissue termed "erosion" was obscure. Various theories were advanced to explain the condition, but it has now been demonstrated by clinical observations and experimental evidence that "erosion" is to be attributed to the abrasive action of gritty tooth-powders. The earliest investigations were made by Berdmore, who was the Court Dentist to George III, and he refers to his experiments in the following words:—

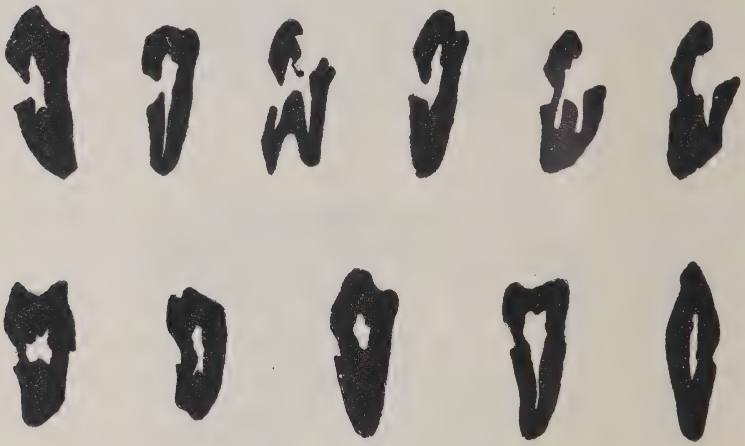

Fig. 548.[1] (Miller).

"I fastened in a vice a sound and well-enamelled human tooth, placing the convex side uppermost. I then took a brush, wetted and charged with a certain tooth-powder, which I had bought for the purpose, and in less than an hour, by rubbing quickly with this brush and powder, I wore away entirely the enamel of the part which was exposed to their action.

"The like experiment I repeated with all the different tooth-powders which are sold in this town, and found the same effects varied only a little in time, according to the coarseness or fineness of the powder, and the different hardness of the enamel.

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[1] From *Dental Cosmos.*

"Now it is well known that a number of people brush their teeth with powders of this kind two or three times a week; and if we allow that the brush and powder generally act on the front teeth briskly for one-fourth of a minute each time, in the space of a month they act three minutes, or in two years seventy-two minutes; that is to say, in the space of two years the teeth have undergone a great deal more brushing than was found sufficient to destroy the finest and best enamel.

"Hence, those that brush with powders only once a week do not destroy the enamel in less than five or six years, and those who use powders but rarely can never be brought to believe that their teeth are injured by them, because the destruction creeps on too slowly to be observed."

This work of Berdmore seems to have been forgotten. Miller more than a century afterwards published a series of articles[1] in which he conclusively showed that "erosion" so-called was due to the abrasive action of the tooth-brush and tooth-powder.

If a tooth is subjected experimentally to the action of the tooth-brush and powder, defects can be produced, the loss of tissue depending largely on the character of the powder used.

In order to make a satisfactory experiment with tooth-brush and powder the tooth to be experimented upon should be fixed in plaster of Paris, with gutta-percha on either side to represent the approximal teeth.

Fig. 548, from Miller, shows the effects produced by different tooth-powders applied with a brush for two hours. Fig. 549 shows the result of brushing for eighteen hours with a tooth-paste which is in common use. The amount of friction applied to this tooth roughly corresponded to brushing for ten seconds daily for eighteen years. The tooth tissues and the gold filling in the first premolar are worn away equally.

An interesting experiment, undertaken by Miller, consisted in arranging a bar of wood opposite the cutting edges of the mandibular front teeth at a distance of from 2 mm. to 3 mm., and brushing for eighteen hours with an English tooth-paste. The result is shown in fig. 550. Not only have grooves been produced near the necks of the teeth, but a considerable amount of tissue has disappeared at the cutting edges. This experiment approximately simulates the conditions where the teeth are brought almost edge to edge when being brushed so that the bristles of the brush work freely along the cutting edges of the teeth and produce abrasion. The condition shown in fig. 547 is brought about in this way.

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[1] The student is advised to read W. D. Miller's articles on this subject in the *Dental Cosmos*, January, February, March, 1907.

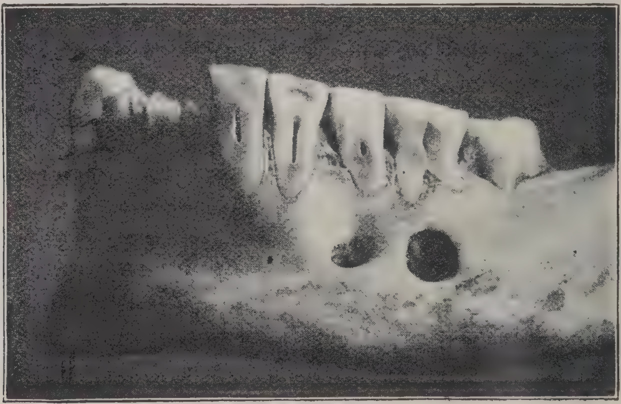

Fig. 549.[1] (Miller.)

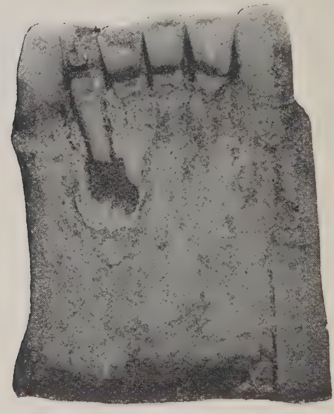

Fig. 550.[1] (Miller.)

"Erosion" is considered by several writers to be due to the action of acid on the tooth tissues. The action of acids varies on the different tooth tissues. "Some acids form soluble and others insoluble compounds which may be precipitated upon the surface of the tooth or in its superficial layers." Certain acids, e.g., hydrochloric, nitric, lactic, &c., decalcify dentine more rapidly than enamel; other acids, such as oxalic, tartaric, or mucic, act on enamel and dentine with equal intensity. Acid action leaves a rough surface, in "erosion" the surface is smooth and polished.

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[1] From *Dental Cosmos.*

Workers in dynamite manufactories often suffer from a disease which causes the loss of the crowns of the mandibular incisors and the cutting edges of the maxillary incisors, the defective portions of the teeth presenting a smooth polished surface. Miller discovered that a similar effect could be produced by exposing teeth to the vapour of sulphuric and nitric acids (the acids used in the manufacture of dynamite), and then slightly brushing the affected surfaces. Here the eroding body is nitrogen peroxide.

Water charged with carbonic acid has a marked decalcifying effect on dentine and enamel, and it is conceivable that carbonic acid, when present in the saliva in excess, might have a deleterious effect on the teeth.

If teeth be acted upon by a constant stream of dilute acid solution, destruction of the tooth substance will ensue, but the surface will be rough, showing acid action, and not smooth as in cases of abrasion.

G. V. Black[1] experimented as follows: The roots of two fresh healthy premolars were enveloped with gutta-percha so that only the crowns were exposed; the teeth, with their approximal surfaces together, were then placed in a jar containing dilute hydrochloric acid (1 in 400) which, by means of an ingenious apparatus, was set in motion; the teeth were arranged in the jar in such a position that a current fell upon their outer surfaces but struck one of the surfaces with greater force than the other. The result was that the cusps disappeared and a groove was formed between the teeth, this groove being more marked upon the surface which received the greater force of the current. Many other experiments were made, and it was found that strong solutions produced general softening, while a solution of 1 of acid in 5,000 of water had no appreciable effect after three months' trial.

Head[2] has investigated the action of acids on enamel, and he has shown that the structure resists the decalcification of acids and acid salts most unevenly and erratically. In experiments with 1:20, 1:2,000, and 1:20,000 solution of acid sodium phosphate, he found that while with 1:20,000 (solution) decalcification of the enamel did not start so quickly as with 1:20, the action of the

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[1] "American System of Dental Surgery," vol. i, p. 1004.

[2] *Dental Cosmos*, vol. xlix, p. 801.

1:20,000 was more uniformly progressive and ended by cutting the enamel much more deeply than the 1:20 solution. Head has also shown that the saliva considerably inhibits the action of carbonic acid and many other acids, such as lactic, citric, &c.

To investigate *the action of acids in combination with mechanical action* Miller subjected teeth to the action of the acid by means of a thin layer of cotton-wool placed on the surfaces of the teeth and then applied friction with a tooth-brush. Every precaution was taken to simulate the condition met with in the mouth, and various acids were tried. In one of the experiments, "six teeth, central, lateral, canine, premolar, first and second molars, were placed in a curve to reproduce the natural arch, and were bathed with 5 per cent. solution of phosphoric acid for thirteen hours, brushed hourly for two minutes with 50 per cent. pumice, and then for eleven hours brushed hourly for three minutes, and for seventy-three hours four minutes hourly." The result of this experiment is seen in fig. 551. The canine and premolar were filled with gold and gutta-percha,

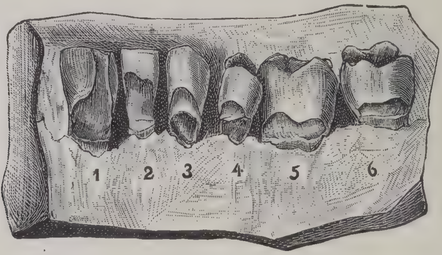

Fig. 551.[1] (Miller.)

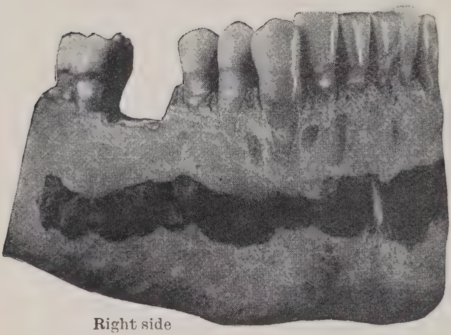

Fig. 552.[1] (Miller.)

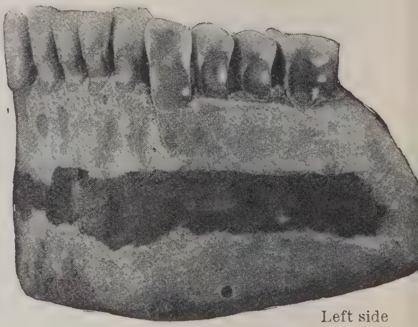

Fig. 553.[1] (Miller.)

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[1] From *Dental Cosmos.*

respectively, and these fillings project above the surrounding dentine.

The result of an experiment undertaken to show the difference between mechanical friction alone and mechanical friction plus acid action is shown in figs. 552 and 553. The teeth in the left half of the mandible were treated with a $\frac{1}{2}$ per cent. to 1 per cent. solution of acid calcium phosphate applied on cotton-wool[1] and in the right half with water, also applied on cotton-wool. Both sides were brushed twice a day with different powders for two and one-third years. The destruction is much more marked on the left side which was treated with acid calcium phosphate.

Etiology.—Experimental evidence suggests that so-called "erosion" is really a type of abrasion and is due to the mechanical action of the tooth-brush and gritty powder. The question arises: Is it possible that acid agents may be present in the mouth in certain pathological conditions and so aid the abrading process? Many authors maintain that "erosion"[2] is intimately associated with "gout," and that in gouty subjects acids capable of affecting the tooth tissues are produced in the mouth. Clinical observations on patients in private practice certainly tend to show that waste of tooth tissue is more marked in those with a gouty diathesis than in those without. On the other hand, Miller and S. P. Mummery examined patients in the hospitals of London and Berlin and found no case of erosion in twenty-four cases of gout and ninety-nine of rheumatism (eighty-nine chronic and ten acute). Caries at the necks of the teeth was found in many of the patients, but no disintegration of the enamel. Riegner, of Breslau, also examined amongst hospital patients two cases of gout and 115 cases of articular rheumatism and found no wasting of the teeth. These data are interesting in view of the fact that hospital patients rarely use a tooth-brush.

Brubaker[3] considers that the source of the acid which affects the teeth is to be found in an abnormal secretion of the mucous glands of the cheeks and lips. These glands are muciparous, and their secretion is composed of water, mucin and inorganic salts, the chief of which, sodium phosphate, imparts to the fluid its alkalinity. In certain conditions, such as "gout," the secretion increases in quantity and is acid in reaction, the acid sodium phosphate which is formed acting as the decalcifying agent.

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[1] Miller in this experiment does not say how long the acid calcium phosphate was allowed to remain in contact with the tooth.

[2] The term "erosion" has been allowed to remain in the text in several places as it is difficult, and perhaps inexpedient, to do away altogether with a term which has been so universally used for many years.

[3] *Internat. Dent. Journ.*, p. 742, 1894.

Kirk,[1] who has carefully studied the question of the connection between the saliva and erosion, is of opinion that "erosion" is intimately connected with the gouty and rheumatic diathesis.

He considers that when the erosion is "general," that is, when it attacks the teeth generally, lactic acid is the solvent, but that, when the condition is localized, the agent is acid sodium phosphate or acid calcium phosphate derived from abnormal secretion of the mucous glands.

Cook[2] contends that mucic acid is an important acid agent in the production of "erosion," and thinks that it is produced by a series of changes from lactose. It is, however, an open question whether mucic acid is ever present in the mouth.

Michaels[3] states that, where "erosion" is found, the saliva of the patients contains an increased amount of sulphocyanide in the form of the ammonium and potassium salts and that by submitting the tooth to a slow drip of a solution of sulphocyanide of potassium for a few days he was able to produce conditions similar to erosion.

A marked destruction of tooth tissue is occasionally seen in patients who consume a large amount of fruit in the form of oranges, grapes and lemons, but in these cases the effect produced on the teeth is not the same as in cases of "erosion." In the case of a patient who was frequently sucking lemons and had acquired the habit of sweeping the tongue over the labial and then over the palatal aspects of the maxillary teeth it was found that the enamel had almost disappeared.

During recent years the number of patients with "erosion" of the teeth has progressively diminished and the condition is now seldom seen. Concurrently, the materials used for cleaning the teeth have undergone a change, tooth-pastes having largely superseded tooth-powders. The friction agent has therefore been disappearing from the dental toilet, but conditions likely to give rise to abnormal secretion of the salivary glands have still been present.

From the foregoing statements it will be seen that varying opinions as to the cause of "erosion" are held by those who have investigated the subject. The facts elicited from a general review of all the information at present at our disposal would seem to show conclusively that **the condition is due to the abrasive action of the tooth-brush and tooth-powders.**

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[1] *Items of Interest*, July, 1902, and *Dental Review*, May, 1903.

[2] *Dental Review*, May, 1906, p. 461.

[3] "On the Rôle of Systemic Hyperacidity and of Sulphocyanides in the Saliva in Chemical Abrasion of the Teeth," *Internat. Dent. Journ.*, vol. xxi, p. 248.

Treatment.—In the first place, tooth-powders should be avoided and a soap with a soft brush used for cleansing purposes. The teeth must on no account be brushed "crosswise." If the abraded areas are painful, they may be touched with phosphoric acid, chloride of zinc, or, if in a position not exposed to view, nitrate of silver may be used, or a paint may be prescribed, the patient being instructed to dry the tooth and paint it with the solution, keeping the tooth dry to allow the material to harden. The following will be found useful:—

℞ Gum-mastic (powder)	ʒi
Zinc chloride	gr. v
Chloroform	℥ss

Mix. To be used as a paint.

If the cavities are deep and are likely to harbour food débris, they should be filled.

(B) ATTRITION

Attrition is a wearing away of the tooth substance, caused by the grinding of one tooth surface over another. It is seen mostly in the deciduous teeth and in the teeth of the aged. The amount of attrition depends to a great extent upon the character of the food, the density of the tooth substance, and the power of mastication. The surfaces of all the teeth may be affected, or only one or two teeth may be attacked. When confined to one or two teeth, the attrition is generally due to some irregularity of the bite. Fig. 554 shows a good example of attrition due to an irregularity of the bite—the mesial angles of the maxillary first incisors impinge upon the mandibular first incisors.

Broca has suggested the recognition of **four degrees of wear**:—

In the **first,** the enamel alone is worn without any obliteration of the cusps; in the **second,** the tubercles of the crown have disappeared, and the dentine is exposed; in the **third,** the height of the tooth is still further reduced; in the **fourth** the wear has extended to the neck, the crown having entirely disappeared, and either the pulp cavities are invaded, or barriers of secondary dentine have formed.

Involuntary grinding of the teeth, leading to undue attrition, is not uncommon in children and is sometimes met with in adults, more especially those with gouty or rheumatic tendencies. Marie and Pietkiewicz[1] state that the habit of grinding the teeth frequently develops in the course of disorders of the central nervous system.

Examined microscopically, the dentinal tubes in cases of attrition will be seen to end abruptly upon the worn surface, while the pulp chamber will show the formation of secondary dentine, though the secondary dentine will not always be found to have kept pace with the destructive process.

Treatment.—In most cases, treatment is unnecessary. If the posterior teeth have been lost, and the anterior teeth are being worn away through bearing the brunt of mastication, the bite should be taken off the anterior teeth by means of dentures. If the patient refuses to submit to dentures, the progress of the destruction can be arrested by filling the cavities with metal and bringing the filling over the edges of the enamel in such a way that, in occlusion, the fillings come in contact and so arrest the progress of tooth destruction. The latter treatment is effectual, but the appearance produced is somewhat unsightly.

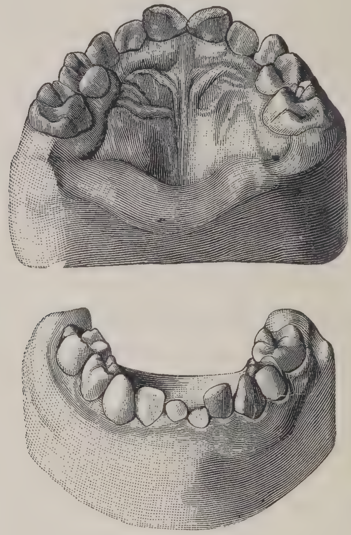

Fig. 554.

The hypersensitiveness of dentine, which at times accompanies rapid attrition, should be treated as indicated on p. 401.

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[1] *Revue de Stomatologie,* March, 1907.

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CHAPTER XIV

Diseases of the Pulp

The Protective Action of the Pulp—Local Reaction to Injury (Pulpitis)—Regressive Changes—Fibrosis—Fatty Degeneration —Colloid Degeneration—Calcareous Deposits

(A) THE PROTECTIVE ACTION OF THE PULP

Whenever the dentine is injured a definite response takes place in that portion of the pulp contiguous to the region of the pulp end of the dentine fibrils which have been exposed by the injury. The response of the pulp is evidenced by fresh formative activity resulting in the production of a modified type of dentine usually known as secondary dentine. If this response (of the pulp to injury of the dentine) did not occur, the pulp cavity would be more frequently exposed and the life of the pulp jeopardized.

Hunter was the first to recognize this property of the pulp, for he remarks that: "A tooth often wears down so low, that its cavity would be exposed if no other alteration were produced in it. To prevent this, nature has taken care that the bottom part of the cavity should be filled up with new matter, in proportion as the surface of the tooth is worn down."

Salter[1] devoted considerable attention to this phenomenon and suggested, for the new tissue, the term "dentine of repair"; while Hopewell-Smith has named it "adventitious dentine."

The new formation may be observed in its simplest form in cases of abrasion and attrition where, the injury to the dentine being of a slow progressive nature, the pulp is not hurried in its task and the freshly formed tissue is strictly limited to the area of the affected fibrils, as shown in fig. 555.

It will be observed that in the affected area the fibrils appear to be more calcified than in other portions of the tooth substances, a fact which suggests that a definite reaction to the injury also takes place in the fibrils. The greater calcification of the affected fibrils is shown by the increased difficulty in staining them.

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[1] "Dental Pathology and Surgery."

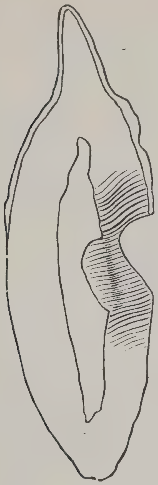

FIG. 555.—Section through a tooth affected with abrasion; the formation of secondary dentine is strictly limited to the pulp region of the injured fibrils.

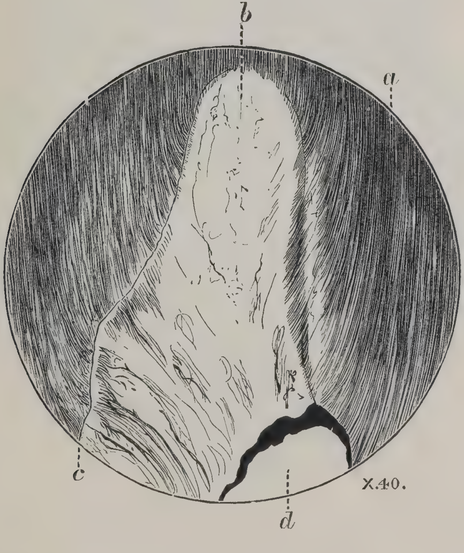

FIG. 556.—Section through a tooth the dentine of which was exposed by attrition: (*a*) primary dentine; (*b*) secondary dentine with a few fine dentine tubes; (*c*) line of demarcation; (*d*) pulp chamber.

There is invariably a definite line of demarcation between the primary and secondary dentine; this is shown in fig. 556.

The structure of secondary dentine varies considerably in different circumstances, and the variation is probably dependent to a great extent upon the nature of the injury, which, in its turn, affects the rapidity of formation. Hopewell-Smith has described[1] five varieties—*fibrillar*, *areolar*, *laminar*, *cellular*, and *hyaline*.

In the **fibrillar** form the tissue may approximate to normal fine-tubed dentine, an abrupt bend of the tubes being all that there is to mark the junction of the two tissues (see fig. 557). In many specimens, however, the tubes are less regular and not so plentiful (see fig. 556). The fibrillar variety of secondary dentine follows prolonged injury of a low intensity.

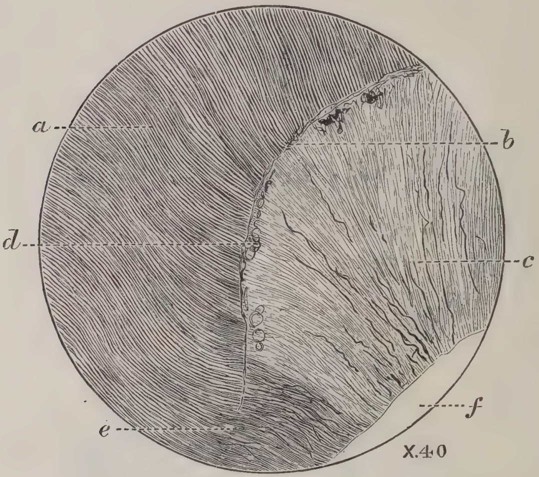

FIG. 557.—Secondary dentine, fibrillar variety; (*a*) primary dentine; (*b*) limit of original pulp cavity; (*c*) secondary dentine; (*d*) interglobular spaces; (*e*) tubules intermingling freely; (*f*) pulp cavity.

The **areolar** variety (fig. 558), which in its general characteristics resembles a dentine filled with interglobular spaces, would seem to occur when the new tissue has been formed rapidly as the result of rapid caries. Such newly formed tissue possesses but little resistance to the carious process and becomes quickly infected (figs. 559 and 560).

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[1] See *Trans. Third International Dental Congress*, Paris, 1900.

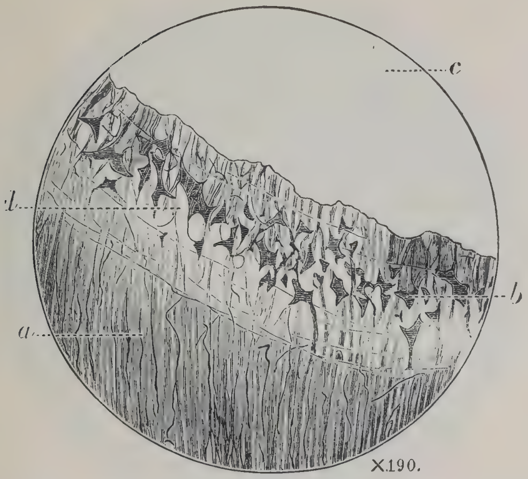


FIG. 558.—Areolar secondary dentine. (*a*) carious dentine; (*b*) interglobular spaces; (*c*) pulp cavity; (*d*) newly formed and irregular-tubed dentine.

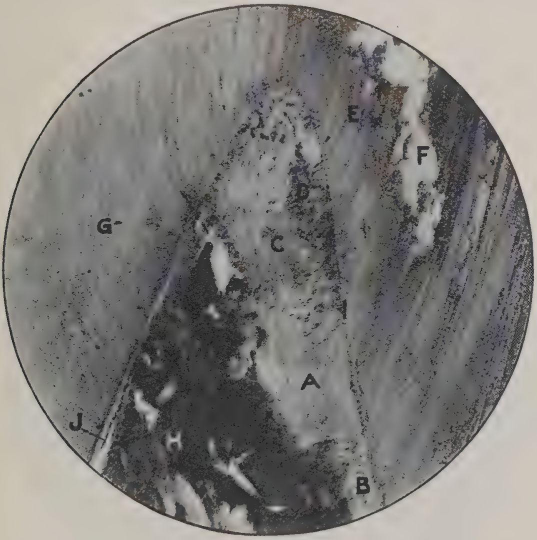
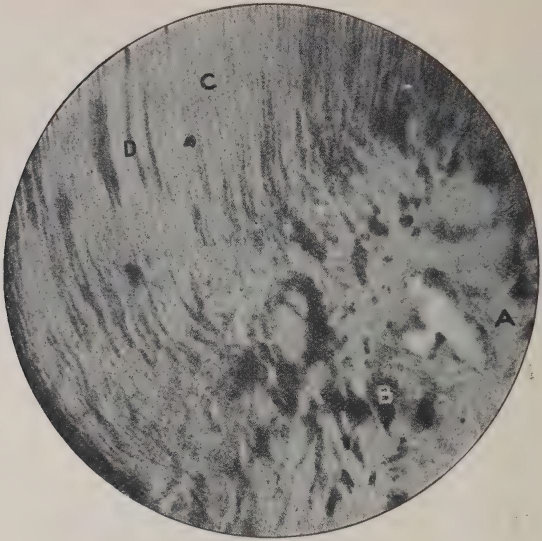
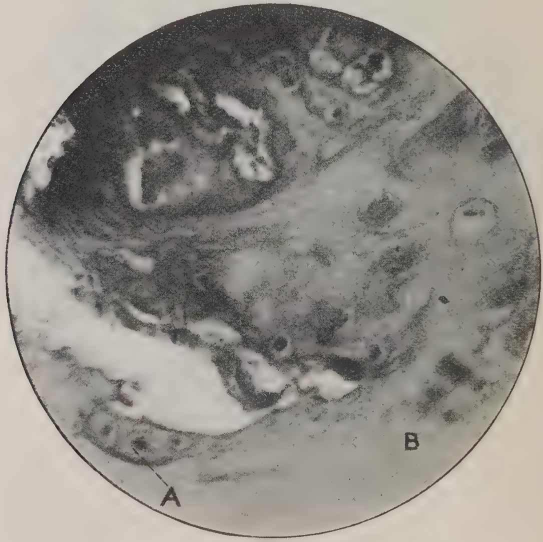


FIG. 559.—Photomicrograph by Hopewell-Smith. Areolar and fibrillar secondary dentine. (A) secondary dentine with fibrillar structure at B, and areola at C, which at D is infected with micro-organisms from caries at E; (F) carious cavity; (G) primary dentine; (H) pulp tissue showing signs of reaction; (I) junction of primary and secondary dentine; (J) layer of odontoblasts.



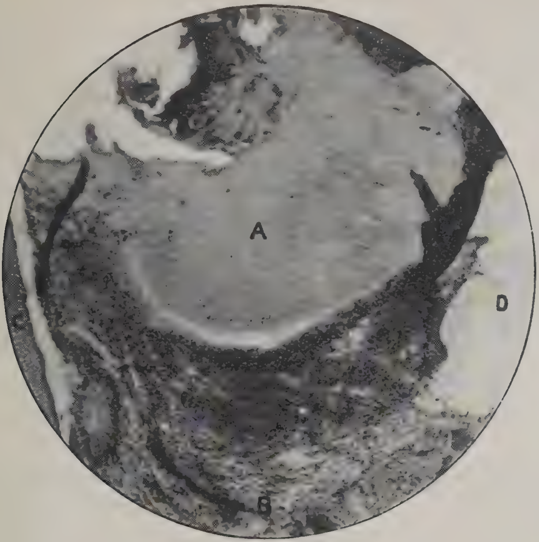
× 300.

Fig. 560.—Photomicrograph by Hopewell-Smith. Secondary dentine infected by micro-organisms from the primary dentine. (a) secondary dentine; (b) masses of micro-organisms; (c) primary dentine; (d) carious dentine.



× 250.

Fig. 561.—Photomicrograph by Hopewell-Smith. Cellular secondary dentine. (a) encapsuled cells with nuclei; (b) structureless matrix.



× 40.

Fig. 562.—Photomicrograph by Hopewell-Smith. Hyaline secondary dentine. (a) ground-glass-like dentine; (b) pulp tissue showing reaction; (c) primary dentine; (d) abscess cavity.

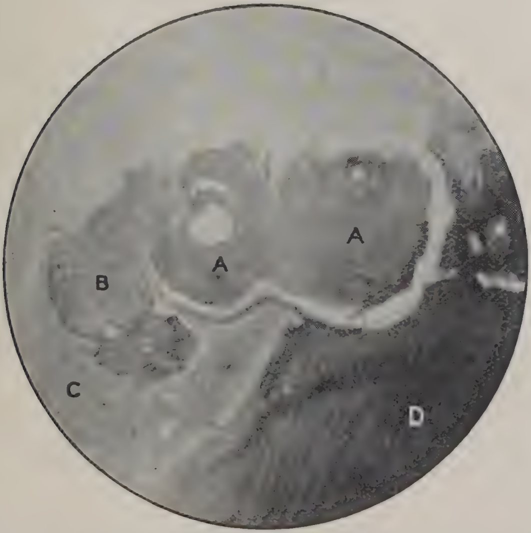


Fig. 563.—Photomicrograph by Hopewell-Smith. Laminar secondary dentine. (a) laminar dentine; (b) cellular dentine; (c) pulp tissue showing signs of reaction; (d) primary dentine.

The **cellular** type differs from the areolar variety in containing, in the matrix, cells which may be fusiform or round (fig. 561).

The **hyaline** variety is a clear, homogeneous, structureless deposit of dentine (fig. 562); and the **laminar**, as the name suggests, is tissue with a laminated form (fig. 563).

Clinical observations show that the reparative power of the pulp varies considerably in different individuals; in some cases, the tissue destruction by caries is well balanced by the formation of new tissue, while, in others, the power of repair seems to be almost entirely lacking.

(B) LOCAL REACTION TO INJURY—INFLAMMATION—PULPITIS

The local adaptive changes which result from injury to the pulp are generally known as "pulpitis." Two grades of inflammation are recognized, namely, the acute and the chronic; in the former, the development of the inflammatory process is rapid and is accompanied by marked clinical symptoms, while, in the latter, the reaction is slow in development and is accompanied by feebly marked clinical signs—indeed, in some instances, no clinical signs are apparent.

(1) Acute Pulpitis

Causes.—Acute inflammatory reaction in the pulp may arise from *traumatism*, such as rupture of the apical vessels from dislocation of the tooth, fracture of the tooth involving the pulp, or laceration of the pulp tissue in the preparation of the tooth for filling. Another group of causes is the injudicious use of *physical and chemical agents*, for example, the freezing of teeth with ethyl chloride, or the use of a drug like arsenic for the treatment of sensitive dentine. The commonest cause of acute pulpitis is injury from *bacterial toxins* which reach the pulp tissue either through a carious cavity, or, more rarely, viâ the periodontal membrane, as in cases of advanced periodontal disease.

Morbid Anatomy and Pathology.—The changes in the pulp tissue resulting from injury are similar to those which occur in other vascular structures. The process may terminate in *resolution* when the injury has taken the form of a concussion or slight dislocation of the tooth. Resolution may follow after injury of the apical vessels, but this is rare, and in this connection the following case recorded by A. S. Underwood[1] is interesting. Whilst performing immediate torsion on a maxillary second incisor, the tooth was completely dislocated and fell on the floor. It was sterilized and replaced. Two years afterwards the tooth responded to thermal changes and showed no degenerative changes.

In other cases the reaction in the tissues may be so intense in character as to lead to *gangrene* of the pulp. Injury to the pulp is frequently followed by gangrene, the reason being that this delicate tissue is enclosed by unyielding walls and that the increased pressure in the cavity leads to vascular obstruction.

When the injury is due to bacterial toxins, *suppuration* usually follows, and, where the infection is intense, " gangrene " may occur. When suppuration is once established in a part of the pulp, the remainder rapidly becomes involved and the whole of the tissue is eventually destroyed.

The early stages of suppuration of the pulp are shown in fig. 564. In the zone (*f*) bordering on the abscess, the cells show a tendency to the formation of fibroblasts, and this would seem to indicate protective action on the part of the pulp to cut off the pus from the remainder of the tissue. In the tusks of elephants examples of the encapsulation of pus are often met with, and in man it would seem to occur occasionally. Gysi[2] records a case where an abscess in the cornua of a maxillary first molar had been isolated from the rest of the pulp by a wall of secondary dentine, and Miller[3] figures a tooth in which the appearances suggest that an abscess cavity had been bridged over and separated from the main pulp cavity.

Occasionally the pulp exhibits a remarkable power of recovery from injury, as shown in cases where an unsuccessful attempt has been made to remove a tooth and a portion of the root containing a living pulp has been left behind, the superficial portion of the pulp in time being replaced by secondary dentine. A detailed account of such a case is given by C. S. Tomes.[4] Sections of this tooth showed that the widely exposed pulp had been covered in by a layer of secondary dentine, and that, in places, fragments of the original dentine had become embedded in the new tissue (see figs. 565 to 567).

Bacteriology.—Cultural examinations of acutely inflamed pulps show the presence of streptococci, staphylococci and diphtheroids.

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[1] *Trans. Odonto. Soc.*, vol. xviii, p. 98.

[2] *Schweizerische Vierteljahrsschrift für Zahnheilkunde*, 1900, p. 254.

[3] *Dental Cosmos*, vol. xliii, p. 850.

[4] *Trans. Odonto. Soc.*, vol. xxviii, p. 183.

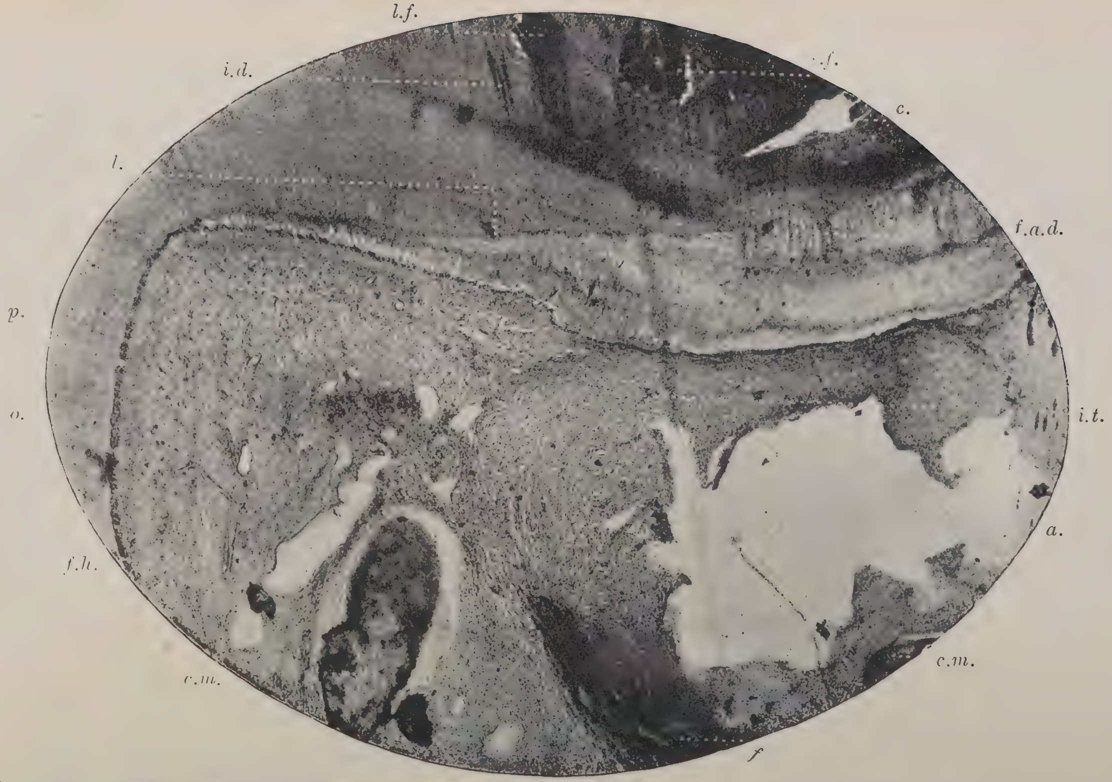

FIG. 564.—Vertical section of human molar tooth affected with caries and inflammation of the pulp. (*c.*) carious cavity; (*i.d.*) dentinal tubes infected with micro-organisms; (*l.f.*) liquefaction foci; (*l.*) original limit of the pulp cavity; (*f.a.d.*) fibrillar secondary dentine; (*p.*) pulp tissue apparently but slightly affected by the inflammatory process; (*o.*) original odontoblasts; (*i.t.*) acute inflammation of the pulp tissue; (*a.*) abscess cavity; (*f.h.*) hyperæmic blood-vessel; (*c.m.*) deposit of calcoglobulin; (*f.*) fibroblasts.

From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

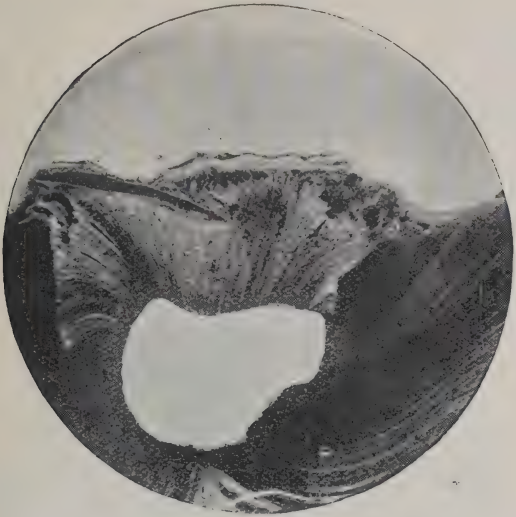

FIG. 565.[1]—General view of the secondary dentine, showing the pulp cavity beneath it and the dentine of the original tooth, which appears very dark. A thin strip broken off the old dentine is embedded in the secondary dentine.

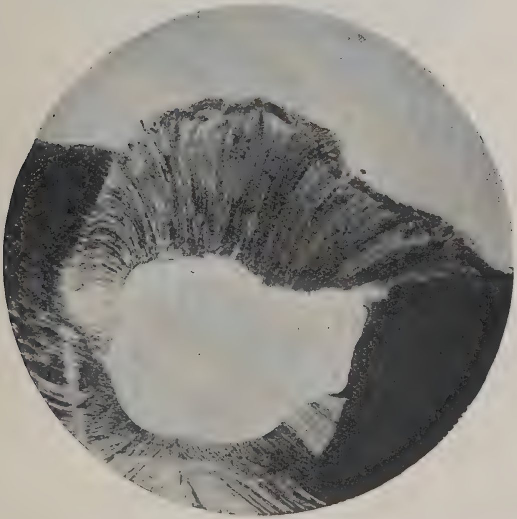

FIG. 566.[1]—Another view of the secondary dentine.

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[1] From *Trans. Odonto. Soc.*

In twelve consecutive cases examined the following organisms were present:—

Streptococcus pyogenes	4	cases
,, *brevis*	8	,,
Staphylococcus albus	6	,,
,, *aureus*	1	case
Gram diplococci	2	cases
Diphtheroids	6	,,

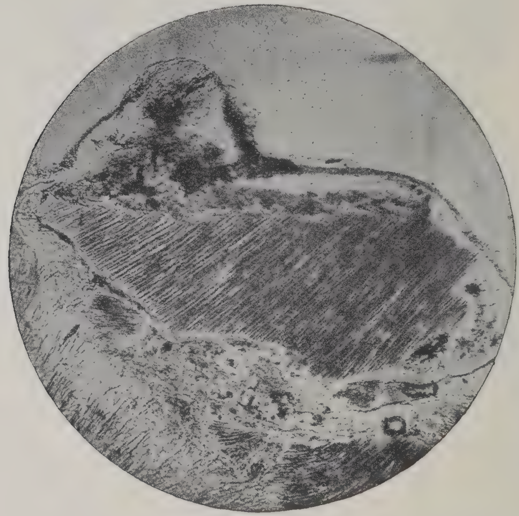

FIG. 567.[1]—A portion of the displaced original dentine embedded in the secondary dentine.

Symptoms.—The symptoms of acute pulpitis are pathognomonic—sharp shooting pain, often of a throbbing character, and generally more severe at night when the patient assumes the horizontal position. Thermal changes also lead to severe paroxysms of pain, although in the early stages of acute inflammation cold produces relief by constricting the blood-vessels. Acute pulpitis must be distinguished from acute periodontitis, and the main points of difference are briefly as follows:—

ACUTE PULPITIS.	ACUTE PERIODONTITIS.
Pain, sharp, throbbing, or lancinating — intermittent and reflected.	Pain dull, heavy, and constant.

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[1] From *Trans. Odonto. Soc.*

ACUTE PULPITIS.	ACUTE PERIODONTITIS.
Thermal changes to the teeth cause pain.	Thermal changes do not cause pain.
Pressure or tapping on the tooth causes no pain.	Pressure or tapping on the tooth causes pain.
Slight pressure on a piece of cotton-wool inserted in the cavity generally causes acute pain.	Slight pressure on a piece of cotton-wool inserted in the cavity does not cause pain, except through pressure transmitted to the periosteum.

Attention to these points will assist in diagnosis, but it must not be forgotten that with acute inflammation of the pulp there is at times a slight inflammation of the periosteum through continuity of the tissues.

Treatment.—When the inflammation is due to trauma, or to the action of physical and chemical agents, there is reasonable probability that resolution will occur. Therapeutic measures must be directed towards the avoidance of fresh injury to the tooth, and counter-irritation should be applied to the gum covering the root, in the form of a drug, e.g., strong tincture of iodine. If the dentine has been exposed by the trauma, the exposed surface should be treated with a strong solution of nitrate of silver. Should the pulpitis be the result of drugs used for treating sensitive dentine, the use of the drugs must be discontinued and the cavity syringed and filled with a non-conducting and non-irritant filling, such as oxysulphate of zinc. Where, however, the clinical features suggest that resolution is not likely to occur, the pulp must be immediately removed. If a pulp is injured by bacterial toxins, experience teaches that extirpation is the best treatment.

(2) Chronic Pulpitis

Chronic pulpitis follows on injuries similar to those leading to acute pulpitis. The reaction of the tissues in chronic pulpitis is different from that seen in the acute form, and this is due to the fact that in chronic pulpitis the injury is constant, though of lesser intensity.

Morbid Anatomy and Pathology.—The character of the reaction of the pulp tissue, when the injury is of long duration, varies considerably. We will first deal with the condition where the pulp cavity is exposed and the pulp tissue is injured by constant doses of bacterial toxins. Suppuration usually occurs and the pulp tissue is destroyed by a progressive ulceration. In some cases cell pro-

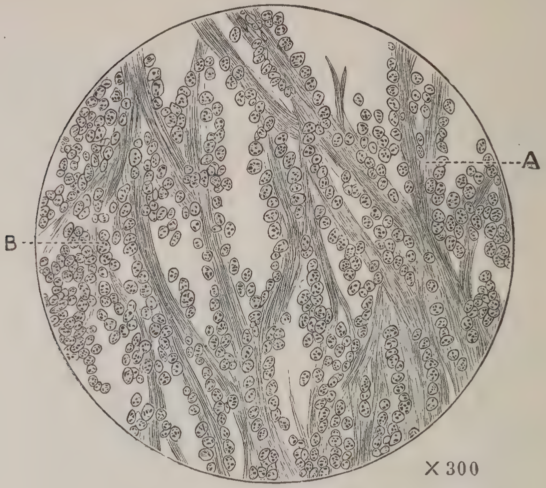

FIG. 568.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section, highly magnified. (A) fibrous stroma; (B) large granular cells (no capillaries visible).

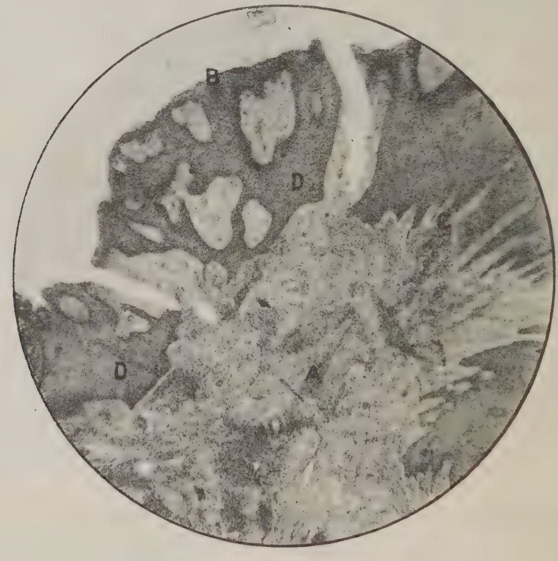

FIG. 569.—Hyperplasia of the pulp—productive pulpitis. Longitudinal section. (A) granulation tissue; (B) epithelial surface; (D) columns of epithelial cells extending deeply into the growth.

liferation is prominent, and is followed by the formation of fibrous tissue, or there may be an overgrowth of the pulp tissue (hyperplasia) giving rise to a flesh-like mass in the carious cavity—a condition known by the clinical expression "polypus of the pulp." A section through a hyperplastic pulp will show granulation tissue which has a tendency to develop into fibrous tissue (fig. 568). The surface is often covered with a layer or several layers of squamous epithelium (fig. 569). The presence of the epithelium has been attributed to "skin-grafting," but an explanation which seems more likely to be correct is that given by Hopewell-Smith[1]—namely, that where the epithelial cells of the gum in the neighbourhood of an approximal carious cavity are irritated by a sharp edge of dentine, they proliferate and extend by direct continuous growth on to the surface of the exposed pulp.

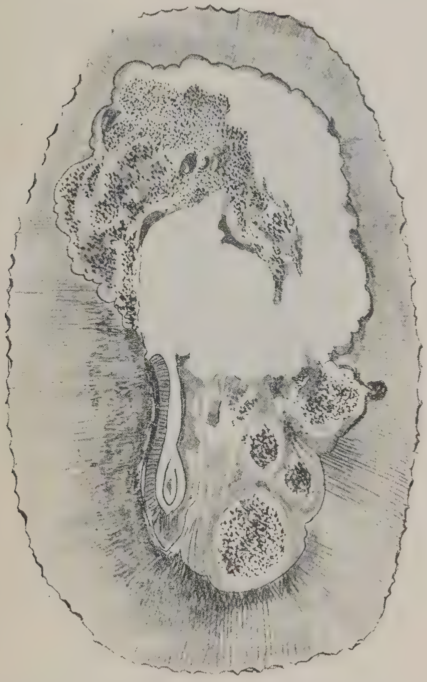

Fig. 570.—Transverse section of a mandibular incisor from a case of "Pink Spot."

From *Brit. Dent. Journ.*

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[1] *Brit. Dent. Journ.*, September, 1909.

There is a type of case in which the dentine and enamel are destroyed from within and the pulp tissue extrudes. The condition is more common in the incisor region than elsewhere, but it is found in other teeth, and its presence is first noticed by the pink appearance of the pulp through the attenuated enamel, an appearance which led to the affection being known as "pink spots." J. H. Mummery has published[1] a detailed account of a case and has suggested that the destruction of the dentine may be due to a chronic pulpitis. In the case he records the normal pulp tissue was replaced by granulation tissue composed of cells and connective tissue in varying proportions, and the wall of the pulp cavity showed absorption areas which, in places, had been filled in with a deposit of osseous tissue with lacunæ, but few canaliculi were apparent (fig. 570). There was a plentiful supply of blood-vessels. In places strong bundles of connective tissue fibres were attached to the walls of the pulp cavity. The cellular element of the growth consisted of endothelial cells, connective tissue cells, leucocytes and large giant

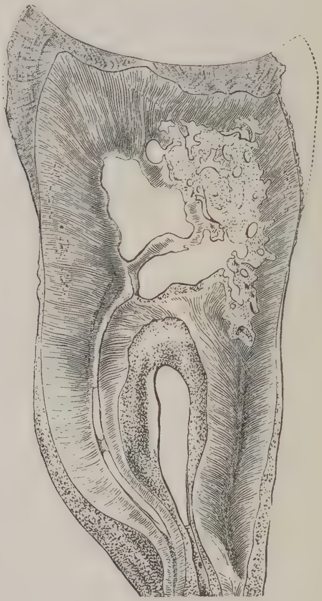

FIG. 571. (Salter.)

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[1] "The Pathology of 'Pink Spots' on Teeth," *Brit. Dent. Journ.*, April 1, 1920, p. 301.

cells. The portion of the pulp in the lower end of the root was fairly normal in appearance.

The case recorded by Salter[1] would seem to belong to this group. The tooth was a mandibular molar and showed three openings just below the edge of the enamel. These canals were short and horizontal, and connected with the interior of the tooth. Sections through the tooth showed that a considerable portion of the dentine had been absorbed and replaced by bone (fig. 571).

We have no definite knowledge of the cause producing the pulpitis in these cases. The condition is sometimes symmetrical, a fact which suggests that a variation in development may be an etiological factor. Occasionally a channel exists between the pulp and the periodontal membrane of a tooth. An example is shown in fig. 572.

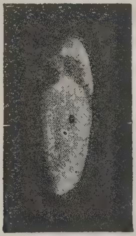

Fig. 572.—A mandibular first premolar with a canal communicating with the pulp cavity.

Lepkowski[1] has shown that in rare instances anastomoses exist in the embryo between the pulp vessels and the vessels external to the tooth germ, and it seems likely that these anastomoses may occasionally persist and give rise to the abnormality shown in fig. 572.

It seems possible that in cases of "pink spots" the pulp tissue may become infected viâ an abnormal canal. A case that came under my own notice supports such a view. The tooth affected was the maxillary left first incisor; there was no periodontal disease, but the gingival margin had been destroyed in places by too vigorous use of the tooth-brush. On the mesio-labial aspect of the root about one-eighth of an inch above the enamel margin there was a small rounded opening. The fleshy tissue projecting from the opening was extremely sensitive and proved to be connected with the pulp. Under cocaine anæsthesia a canal leading to the pulp cavity was detected.

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[1] "Dental Pathology and Surgery," p. 79.

[1] *Die Vierteilung der Gefässe in den Zähnen des Menschen* (Anatomische Hefte), H. liv.

(C) REGRESSIVE CHANGES

(1) Fibrosis.—In this condition the normal tissue of the pulp is replaced by fibrous tissue. The replacement may be partial or complete. These changes have been ably described by Wedl[1] and Hopewell-Smith.[2] The latter has shown that complete fibrosis of the pulp—in which all the elemental tissue has degenerated or has changed in character, the cells, the vessels, the nerve fibres, &c.—may occur in teeth of the deciduous series.[3] To the naked eye, the pulps appear flattened and shrivelled; and they are often brittle in

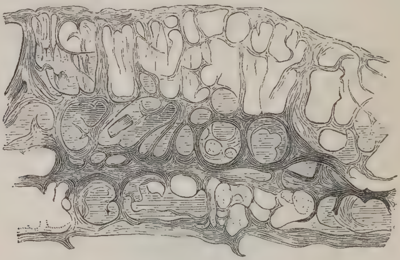

Fig. 573. (Wedl.)

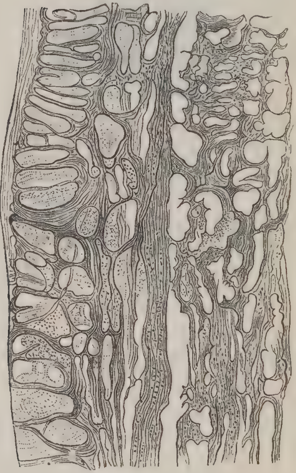

Fig. 574. (Wedl.)

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[1] "The Pathology of the Teeth," p. 237.
[2] *Journ. Brit. Dent. Assoc.*, March, 1892.
[3] *Dental Cosmos*, December, 1909.

consistency. Their colour is grey-yellow or reddish-brown according to whether they contain a smaller or larger amount of necrotic blood.

Microscopical Appearances.—*Under low magnifying powers* a superficial reticular network is seen, at the edges of which the odontoblasts appear shrunken, while, if the atrophy is far advanced, they will have disappeared. The blood-vessels appear larger than usual and have thin walls, so that it is impossible to distinguish between arteries and veins. The nuclei in the sheath have also disappeared. The vessels are seen to take an irregular course and to intertwine freely, marked constrictions due to the contraction of the connective tissue trabeculæ being present in places. *Under higher powers* (300 diameters) the network becomes more plainly visible, the bundles of tissue interlacing and forming alveolar-like spaces, the central spaces corresponding to the shrunken blood-vessels. The nerve sheaths are fatty, granular, and, in places, covered with small concretions of lime. In various places staining is visible. The staining arises from the colouring matter of the blood. Calcareous deposits of round, elliptical, cylindrical shapes are also seen in the tissue of the pulp (figs. 573 and 574).

In the sections shown (figs. 575 and 576) the cellular elements of the pulp are totally absent.

The condition has been described as senile atrophy, but as a certain degree of fibrosis is invariably present in the pulps of teeth affected with periodontal disease the accuracy of the description is questionable. Turner and Drew,[1] Heath[2] and others have shown that the pulps of such teeth are invariably infected. In spite of this fact it is the exception for such pulps to react sufficiently to give rise to symptoms of pulpitis. It would seem probable therefore that the toxicity of the organisms present in the pulps is of slight intensity. The condition is possibly similar to that described by Adami as sub-infection. The pulp tissue may have the power of destroying organisms, but if the number destroyed is excessive a poisoning of the pulp cells follows with degenerative changes and finally death. Replacement of the dead tissue cells by fibrous tissue usually follows such localized cell destruction.

(2) Fatty Degeneration.—This is mostly found in the pulps of senile teeth, and in teeth which have been treated with the view of retaining the pulp alive. To the naked eye, the pulp is diminished in volume and is of a pale reddish-grey colour with traces of yellow.

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. xii, p. 104.

[2] *Brit. Dent. Journ.*, August 15, 1921.

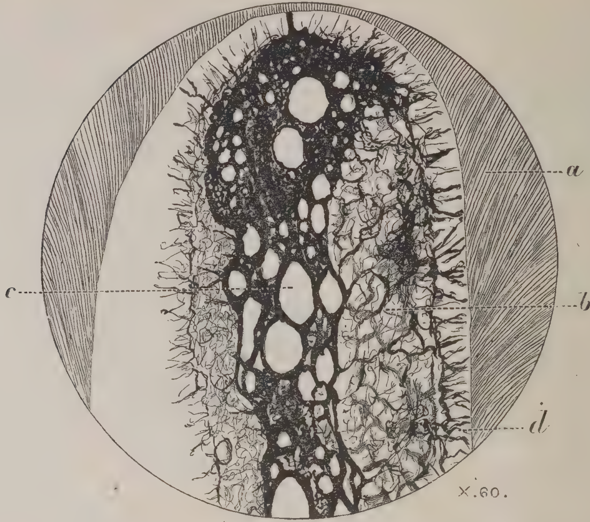

FIG. 575.—(Transverse section.) (*a*) dentine; (*b*) reticular pulp tissue; (*c*) areolæ; (*d*) degenerate odontoblasts.

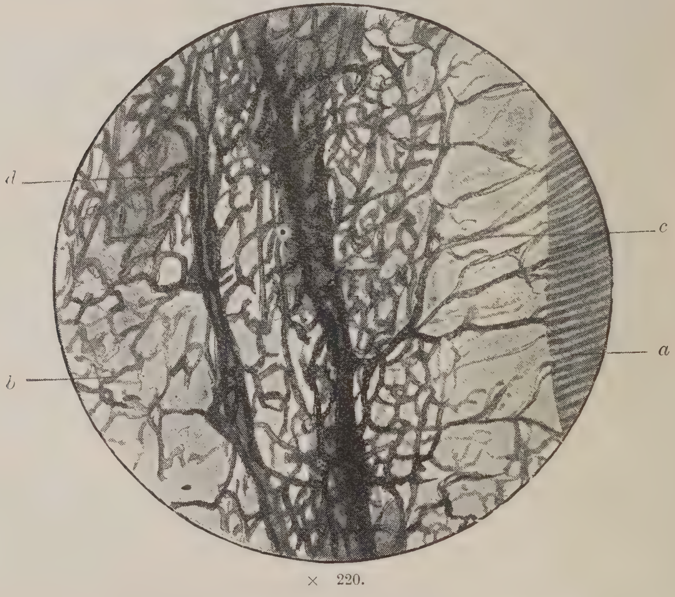

FIG. 576—(Longitudinal section.) (*a*) dentine; (*b*) reticular pulp tissue; (*c*) degenerate odontoblasts; (*d*) fibrous cylinder.

Occasionally it is of a cheese-like consistency, while in very advanced conditions a soft greasy mass is present in the pulp chamber. According to Wedl, this mass is composed merely of a dirty brownish-yellow detritus, with traces of a fibrous structure, together with clusters of stellate fatty-acid crystals. Where a pulp is the subject of fatty degeneration, reaction to thermal stimuli is much diminished and, in advanced cases, entirely lost.

Microscopical Appearances.—The odontoblasts appear degenerated and form a layer upon the surface of the pulp. The parenchyma of the pulp contains fat globules which form chains and follow the course of the vessels and nerves. The medullary sheath of the nerves and walls of the vessels also undergoes degeneration.

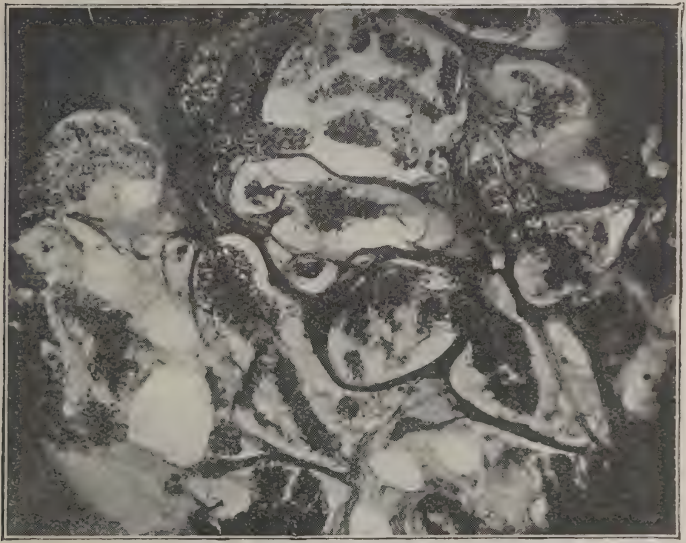

Fig. 577.—Colloid degeneration of the pulp. From Burchard's "Text-book of Dental Pathology."

(3) Colloid Degeneration.—Latham[1] has demonstrated the presence of colloid material in the pulp, and an illustration from her paper is shown in fig. 577. Colloid degeneration of the pulp is rare.

(4) Calcareous Deposits.—Calcareous deposits are frequently met with in pulps which have been the seat of inflammatory reaction. These deposits must be carefully distinguished from secondary dentine, that is, the addition of fresh dentine to the original boundaries of the pulp chamber. Calcareous deposits are occasionally met with in apparently healthy pulps, and in such cases it is doubtful if they are of pathological significance.

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[1] *Journ. American Med. Assoc.*, September 22, 1906.

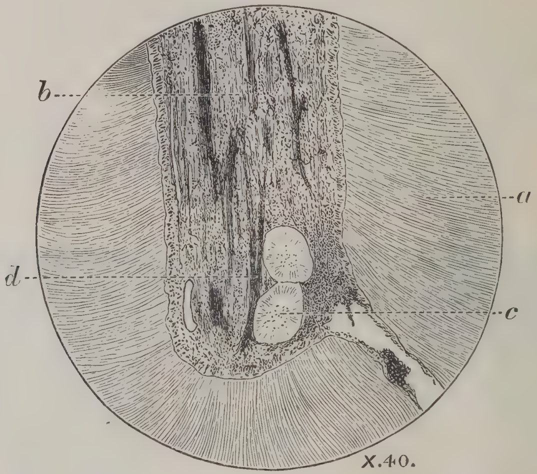

FIG. 578.—Pulp nodules (longitudinal section). (*a*) dentine; (*b*) normal pulp tissue; (*c*) pulp nodules; (*d*) nerve bundles.

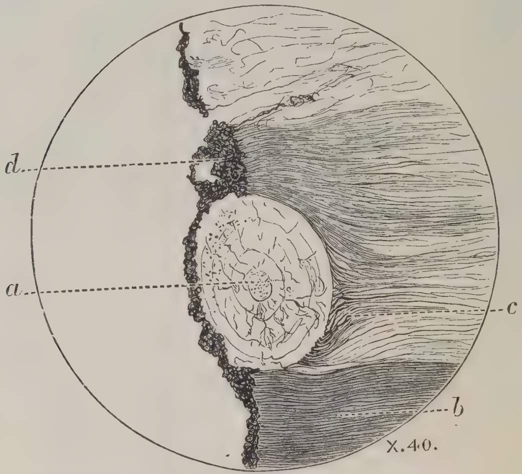

FIG. 579.—Pulp nodule fixed to wall of cavity. (*a*) pulp nodule; (*b*) dentine; (*c*) bent tubes of dentine; (*d*) soft tissue adherent to specimen.

The simplest form of calcareous deposit is a small pulp nodule. On examination of the tooth after its extraction, these nodules are just visible to the naked eye, and, under a low magnifying power, are seen to be concentrically laminated; in some, not fully calcified, the central portion presents an irregular appearance. Pulp nodules are formed near the periphery of the pulp, and, though developed in its tissue, eventually become included in any secondary dentine that may be formed, the dentinal tubes bending round the nodule.

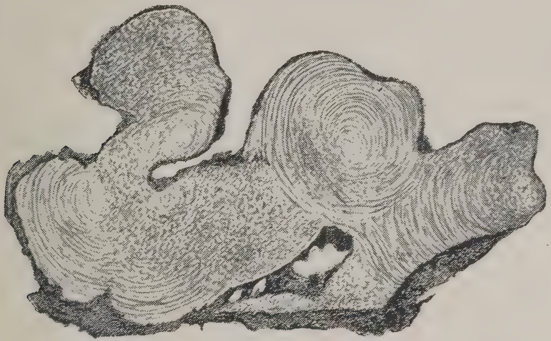

Fig. 580.—Semi-diagrammatic.

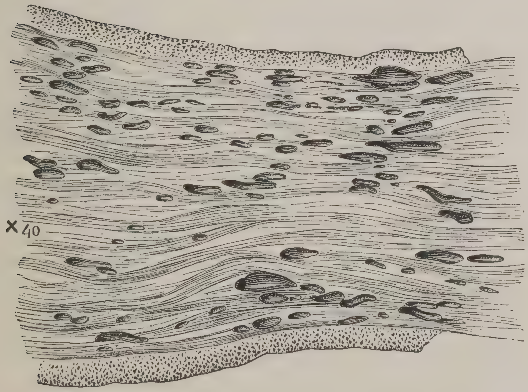

Fig. 581. (Salter.)—From a pulp treated with a solution of caustic potash.

Fig. 578 represents two small pulp nodules from the tooth of a child, aged 14, which was removed for irregularity. In fig. 579 the pulp nodule is seen to be projecting from the wall of the canal, having become enclosed by the new formation of dentine. In the coronal pulp of the molars, the nodules reach a much larger size, and, viewed under a very low magnifying power, are seen to be lobulated in outline; on section many are apparently composed of a number of small nodules joined together by a structureless material (fig.

580). These pulp nodules occur amongst the tissues of the pulp, and must be differentiated from calcification of the tissues of the pulp. Black considers that the deposits of calcoglobulin bear some relation to the formation of pulp nodules. Pulp nodules are probably due to an effort on the part of the pulp to wall off some harmful substance, the nucleus being formed by tissues which have died.

In pulps showing a tendency to fibrosis there is often a deposit of calcareous material. The deposit may be in the form of small cylinders which lie parallel to, and are attached to, the fibrous tissue (fig. 581). To the naked eye, the pulp appears stiff, retaining its shape when removed from the canals and resuming its shape after being bent. To the touch, the pulp feels gritty. In advanced stages the cylinders coalesce, being jointed together in an irregular manner. The lumen of the pulp canals is usually diminished in consequence of the formation of secondary dentine.

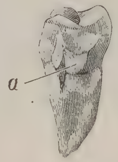

Fig. 582.—(*a*) calcified pulp.

The whole tissue of the pulp may undergo calcification (fig. 582). To the naked eye, the deposit appears non-nodulated and thus differs from the pulp nodule. As a rule, it is regular in outline and presents a smooth surface. Microscopically, the appearances vary. In some cases the calcified tissue element of the pulp is apparent; in others it appears granular on section with a few irregular tubes scattered here and there, or it may exhibit virtually no structure at all.

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CHAPTER XV

The Treatment of the Dental Pulp

The Operation of "Capping"—Extirpation of the Pulp—Mummification of the Pulp—The Treatment of Septic Pulp Canals—Methods of Bleaching Teeth

(A) WHEN THE PULP IS NOT EXPOSED

When it is intended to insert a metallic filling and the cavity is deep the floor should be covered with a layer of non-conducting material such as oxysulphate of zinc. The same procedure should always be adopted for any cavity if the dentine appears to be unduly sensitive.

(B) WHEN THE PULP IS EXPOSED AND LIVING

The treatment of the exposed living pulp depends upon the extent of the exposure and the presence or absence of infection. If the exposure has been produced by traumatism during the preparation of a cavity and the surrounding dentine is healthy, an attempt may be made to conserve the pulp; but when the exposure is the result of disease, the pulp should be removed.

(*a*) **Retention of the Pulp.**—The mode of procedure is as follows: Arrest all bleeding from the pulp by syringing with hot water; swab out the cavity with a mild, unirritating antiseptic and carefully dry the cavity. Mix a thin paste of the powder of the oxysulphate of zinc and oil of cloves; introduce it into the concave side of the cap, and place it in position over the exposed pulp, care being taken that the margin of the cap rests upon the dentine and not on any part of the exposed pulp. Hold the cap in position with an instrument and fill the cavity with gutta-percha or some osteo-plastic filling. The cap employed may be made of metal. Caps can be easily constructed by cutting out, with scissors, a circular piece of the material used and giving it a "cup-shape" by pressing upon it with the butt-end of an excavator. At times it is difficult to get the cap into position, especially with the conveying forceps. The difficulty may be overcome by punching a small hole in the cap so that the little flap formed by punching will be on the convex side of the cap, and, if this flap is held with the conveying forceps, the cap may be easily conveyed to the cavity and kept in position. The flap will resume its place on applying the slight pressure used in filling the remainder of the cavity.

(*b*) **Extirpation of the Pulp.**—The first stage consists either in devitalizing the pulp by a drug, or in rendering it insensitive by means of a local anæsthetic.

(i) *Devitalization.*—For this purpose arsenious acid is used, either alone or in combination with other substances. An objection to the use of arsenious acid is the pain caused during its action. The pain can be alleviated by employing the arsenious acid in combination with cocaine hydrochloride and carbolic acid. It is very desirable that the operator should know the exact amount of arsenious acid used, and it is advisable therefore that the drug should be made up in powders containing one-twentieth of a grain with an equal weight of cocaine hydrochloride: one of the powders is mixed with a drop of pure carbolic acid and applied to the surface of the pulp under the cap of metal.

The mode of application is as follows: The cavity is opened up and all débris syringed out with warm water. The carious dentine is next removed. It is not always possible to remove all the carious tissue owing to the pain caused, but the portion bordering the edge of the cavity and the part covering the pulp must be removed. The cavity should next be syringed with warm water and measures taken to exclude moisture during the subsequent steps. The cavity should then be dried and the pulp and adjacent dentine disinfected. The dressing is next applied in close contact to the pulp, and over the dressing a concave cap of metal is placed. The cap should be large enough to cover the dressing without pressure, and to allow the edges to rest on the dentine. The cavity is then sealed with gutta-percha or oxysulphate of zinc.

In applying arsenious acid on the approximal surfaces with the cervical margin near the gum there is a risk that the dressing may shift during the introduction of the filling material. In such positions it is best to commence by placing a rim of gutta-percha along the cervical margin beforehand. A small pit will thus be formed and the arsenious acid can then be applied without any risk of the dressing shifting. Fig. 583 explains this point diagrammatically. In the case of isolated teeth an elastic band or silk ligature passed round the tooth will be found useful to keep the dressing in place.

Notwithstanding every precaution arsenious acid may cause great pain during its action. When necessary, counter-irritation to the gum in the form of poultices should be tried. In applying the poultice, contact with the tooth must be avoided. If the poultice is not effective, a sedative, such as "aspirin" in 10-grain doses, should be administered.

The rapidity of the action of arsenious acid on the pulp depends in a large measure on the pathological conditions present. The dressing should remain in position for about two days in cases of acute inflammation; about four days in chronic suppurative conditions; and at least one week in cases where a fibroid or calcareous condition may be suspected. Arsenious acid is variable in its action. Some individuals are peculiarly susceptible to its action and may develop an acute periodontitis within twenty-four hours of the application of the drug; while others seem to be capable of tolerating the drug for an indefinite period. In view of this uncertainty in the action of the drug, the patient should be advised to return at once if the tooth shows signs of tenderness. The prompt removal of the dressing may prevent a troublesome or even intractable periodontitis.

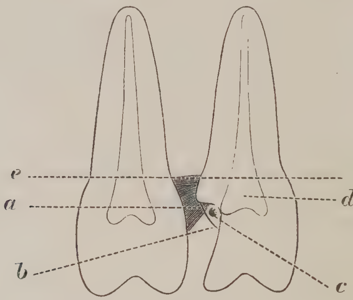

Fig. 583.—(*a*) gutta-percha; (*b*) metal cap covering dressing; (*c*) dressing of arsenious acid; (*d*) pulp chamber; (*e*) line indicating margin of gum.

The escape of arsenious acid on to the gum may lead to sloughing, and, in severe cases, the damage may extend to the alveolar process. Should this occur, the sloughing soft tissue should be gently scraped away and the exposed surface swabbed with tincture of iodine.

Discoloration of the dentine may follow the application of arsenical dressings, and is not always preventable. The precautions to be taken are to relieve congestion of the pulp as far as possible, and to avoid applying the dressing until the bleeding has completely ceased.

(ii) *Anæsthesia.*—The plan generally adopted is known as "pressure anæsthesia." The procedure is as follows:—

The cavity is freed of carious dentine as far as possible, and the surface of the pulp uncovered and swabbed with tincture of iodine. A small pellet composed of cocaine and adrenalin[1] is then placed on the pulp and covered with a piece of unvulcanized rubber, and lightly pressed. As soon as the immediate pain caused by the application has disappeared the pressure may be gradually increased. Pulps vary considerably in their responsiveness to cocaine. In some cases the application of cocaine for a few seconds is sufficient to produce anæsthesia of the whole pulp, while in other cases it may be necessary for the application to last five or even ten minutes. The amount of anæsthesia can be gauged by passing a broach up the canal. The preparation of the cavity should next be completed and the pulp then removed. The bleeding that usually follows must be arrested and the pulp canals filled at once. Clinical experience shows that trouble is less likely to follow if the canal is filled immediately after the removal of the pulp.

The periodontitis that occasionally follows immediate extirpation of the pulp is probably due to infection, the direct result of the pressure, and is likely to follow in cases where active suppuration is present. This complication may be avoided to a great extent by treating the pulp with an antiseptic dressing for twenty-four hours. Periodontitis may also be due to medicaments being forced through the canal into the peri-apical space.

The removal of the pulp may also be carried out under anæsthesia induced by the regional and infiltration methods.

(iii) *Removal of the Pulp and Treatment of the Canals.*—The vitality of a tooth is derived from the pulp and the periodontal membrane; a tooth therefore deprived of its pulp depends for its existence as a healthy and useful part of the body upon a periodontal membrane which has an intact connection with healthy cement. In the case of a normal tooth it is probable that direct plasmic communication exists between the pulp and the periodontal membrane, nevertheless the structure and relation of the various tissues composing the tooth seem to indicate that the dentine is nourished mainly from the pulp and that the cement is nourished mainly from the periodontal membrane.

Success in the treatment of a pulpless tooth depends in a great measure upon the thoroughness with which (1) the pulp can be removed and replaced by a non-absorbent and non-contractile substance, and (2) the soft tissue of the dentine and cement can be rendered sterile and innocuous without injuring the vital connection between the cement and the periodontal membrane. The anatomical relations of the tissues in the region of the foramen necessarily affect

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[1] A convenient form is supplied by Messrs. Parke, Davis and Co. Each pellet contains $\frac{1}{6}$ gr. of cocaine hydrochlorate and $\frac{1}{300}$ gr. of adrenalin.

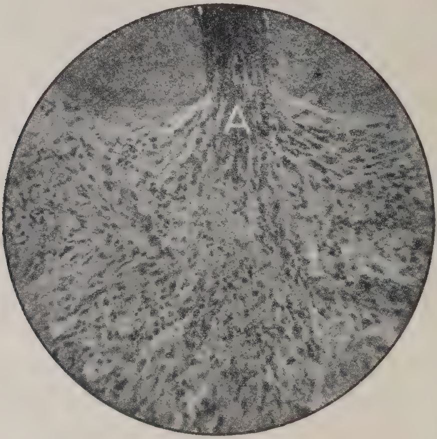

Fig. 584.—Section of the tissues in the region of the apex of a tooth. Note how the periodontal membrane invests the surface of the root and extends into the canal. (A) opening into root canal.

From a paper by C. J. Grove (*Dental Cosmos*).

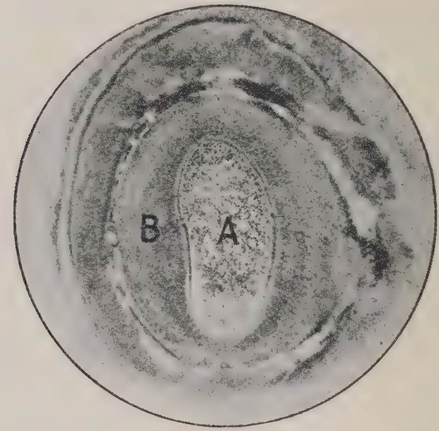

Fig. 585.—(A) foramen filled with cement; (B) dentine.

From a paper by C. J. Grove (*Dental Cosmos*).

the method of treating root canals. The periodontal membrane extends into the foramen and meets the pulp tissues at the narrowest part of the canal (fig. 584). Grove[1] draws attention to these anatomical conditions and lays stress on the importance of avoiding the destruction of the soft tissues in the region of the orifice by the use of chemical agents and instrumentation in the performance of root canal operations. He argues that if the tissue is not injured it may retain its vitality or the orifice may be closed by the formation of a deposit of cement as shown in fig. 585.

In support of this view he puts forward the results obtained from the examination of 1,000 radiograms of pulpless teeth which had been treated. These radiograms he divides into two groups: (1) teeth with rarefied areas; (2) teeth with no rarefied areas. Around teeth with canals filled to the apex he found a greater percentage of rarefied areas than around teeth with canals only fairly well filled.

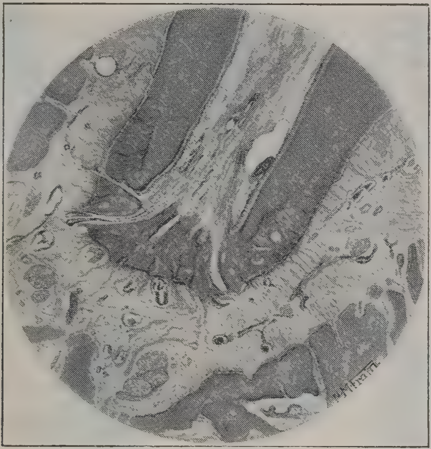

Fig. 586.—Section of tooth showing multiple foramina. From a paper by N. G. Thomas, *Journ. Nat. Dent. Assoc.*

The complete removal of the pulp is extremely difficult if not impossible where the canals are fine, tortuous or bent; where there has been a considerable formation of secondary dentine, and where the pulps have been partially calcified. The pulp canal is frequently far from being a simple, tapering channel; it may be variable in size, may have lateral off-shoots, and the pulp may enter by a number of foramina.

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[1] *Dental Cosmos*, October, 1921.

The variability in the shape of pulps can be demonstrated by Hess's method, which consists in macerating teeth in water, washing out the canals and then packing with rubber. The teeth after being vulcanized are dissolved in HCl 50 per cent. Casts of pulps

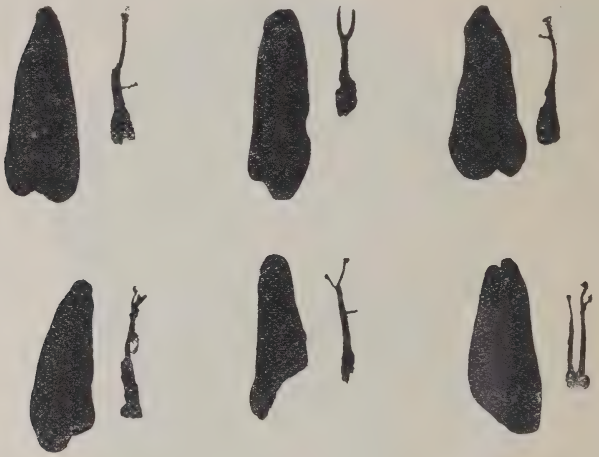

FIG. 587.—Pulps of premolars.
From Parfitt's "Operative Dental Surgery" (Edmund Arnold and Co.).

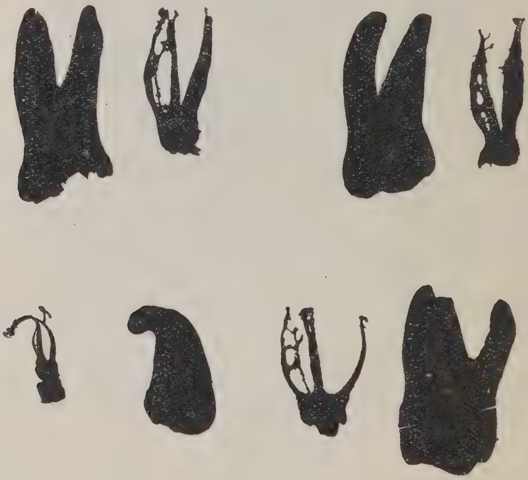

FIG. 588.—Pulps of maxillary and mandibular molars.
From Parfitt's "Operative Dental Surgery" (Edmund Arnold and Co.).

prepared in this way by J. B. Parfitt are shown in figs. 587 and 588. An illustration of a tooth with multiple foramina is shown in fig. 586.

Before an attempt is made to remove the pulp, the pulp canals must be freely exposed and preparation of the cavity completed as far as is practicable. The operations on the pulp should be carried out with strict aseptic precautions. After the removal of the pulp, the canals should be rendered free of débris by the use of peroxide of hydrogen, followed by absolute alcohol. The canal should next be dried with cotton-wool and filled immediately with a material which will tend to coagulate the soft tissues in the dentine. I have used a filling of oxychloride of zinc for some years past with good results. Various drugs are favoured by different operators, and Parfitt[1] states that he has had considerable success with a root filling composed of zinc oxide and zinc sulphate cement mixed with tricresol and paraform, the latter substance being used "in the proportion of 10 per cent. for fine canals in solid thick teeth and 3 per cent. for large canals in young persons."

For filling small canals wood may be employed. The *modus operandi* is as follows: The length of the canal having been ascertained, a peg is selected which fits loosely into the canal. The peg is then covered with oxychloride cement and the filling worked up the canal; the peg is then pushed up to the apex of the canal and a rotary motion used to break the wood. An argument urged against wood is that it is liable to expand from absorption of moisture and split the tooth. To avoid this contingency, the points should be well soaked in paraffin during the process of manufacture. Wood as a filling for root canals has the advantage of being easily passed to the apex of the canal and is capable of being introduced into the fine canals.

The method of treatment suggested by J. Callahan has many strong supporters. The pulp canal is freed of soft tissue and the crown of the tooth coated with a protecting medium such as chloro-resin. A 50 per cent. solution of sulphuric acid is introduced and worked up the canal by means of suitable instruments; the acid slightly decalcifies the dentine and so permits easy access to narrow canals. The action of the acid is, however, self-limiting, as the insoluble calcium sulphate is formed. The acid is followed by the use of a saturated solution of bicarbonate of soda or peroxide of soda, with the result that there is a marked effervescence which expels a considerable amount of organic débris. H. B. Johnston[2] recommends that the sulphuric acid should be sealed in the canal to allow the acid to diffuse through the accessory canals which cannot be reached by instruments, and also to allow time for the organic matter in the canals and canaliculi to yield up its water, shrink, and so become detached from its hold upon the tube wall. The tooth is then dehydrated with a solution of 95 per cent. alcohol, which is removed by an absorbent material and the canal flooded with chloro-resin, followed by the insertion of gutta-percha. Extreme care is necessary to prevent the sulphuric acid passing through the apex and so causing injury to the periodontal membrane.

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[1] "Operative Dental Surgery," p. 238.

[2] *The Journal of the National Dental Association*, February, 1921.

(*c*) **Mummification of the Pulp.**—Wherever possible the pulp canal should be cleared and filled in the manner already described, but there are a few cases where mummification of the pulp is a useful procedure, for example, in the case of molar teeth showing extensive calcification and in the case of individuals who may be unable to endure the tediousness of root canal treatment.

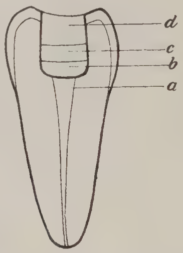

Fig. 589.—(*a*) devitalized pulp; (*b*) mummifying paste; (*c*) osteoplastic cement; (*d*) metal filling.

This operation consists in applying a devitalizing agent to the pulp, and, at a subsequent visit, removing the coronal portion and applying medicaments to the portions remaining in the root or roots and filling the cavity permanently (fig. 589). It is important that all the stages of the operation should be carried out under strict aseptic precautions.

The following preparation suggested by Söderberg[1] gives good results—

℞ Aluminis exsiccati }
Thymol } āā ʒi.
Glycerini }
Zinc oxide q.s. to make a stiff paste.

The thymol acts as the antiseptic, the alum as the mummifying agent, the zinc oxide as the conveying medium, and the glycerol as the binding and penetrating agent.

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[1] *Dental Cosmos*, November, 1895, p. 922.

Miller suggested a mixture of perchloride of mercury 0·0075 grm., thymol 0·0075 grm., made in the form of little pellets. The perchloride of mercury at times causes pain, and also has the disadvantage of staining the tooth structure, but in the case of posterior teeth the staining is immaterial. The living portions of the pulp are rapidly killed by coagulation of the cell protoplasm and are sterilized by impregnation with the sublimate and thymol. H. Bönnecken[1] has devoted attention to this question and gives an account of two cases in which he was able to make a microscopical examination. He found the pulps in a state of fatty degeneration, globules of colloid and calcareous matter being present in the bundles of connective tissue, and the capillaries thrombosed. He suggests treatment with the following preparation forty-eight hours after the application of the arsenical dressing:—

℞ Cocaine }
Thymol } ... ... āā ʒi.
Misce exactissime terendo et adde—
Formaldehyde soluti (40 per cent.) ... ♏xl.
Zinci oxidi ... ... ʒii.
Misce. Fiat pasta.

When cocaine and thymol are rubbed together in the mortar they deliquesce; therefore, after the addition of ten drops of formalin a relatively large amount of oxide of zinc must be added to give the mixture the consistence of a paste. Bönnecken finds that this preparation does not give rise to pain and that there is no discoloration. A stronger percentage of formalin is likely to cause pain.

Pulp mummification is useful in (*a*) fine canals from which the pulp cannot be removed; (*b*) nervous and weak patients unable to undergo tedious root filling; (*c*) canals which are twisted and tortuous.

(C) WHEN THE PULP IS DEAD

Where the pulp has died we are confronted with infection in the pulp chamber, in the dentine, and in the cement, and frequently in the surrounding periodontal membrane. There is perhaps one class of pulpless tooth which is an exception to this rule, namely, the tooth which has lost its pulp from injury but yet remains in position for years without exhibiting any pathological symptoms. It is reasonable to assume that the pulp chambers of these teeth are not infected.

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[1] *Oesterreich-Ungarische Vierteljahrsschrift für Zahnheilkunde,* vol. xi, &c. Translated in *Dental Record,* vol. xviii, p. 158.

The advisability of retaining teeth with septic pulp chambers is discussed on p. 490; and attention will here be drawn only to the methods of treatment to be adopted when it has been decided to retain such teeth. Successful treatment depends upon:—

(1) Complete removal of the contents of the canal.

(2) Sterilization of the tooth tissues.

The first stage in treatment is to remove all the carious tissue and then insert a drug to sterilize the contents of the pulp canals. For sterilization a dressing of cresol mixed with formaldehyde[1] may be applied to the orifice of the canal and allowed to remain in position for about one week. Some authorities object to the use of formalin on the ground that the formaldehyde rapidly disappears and is likely to cause irritation of the soft tissues. Dichloramine-T dissolved in chlorcosane[2] finds favour with some operators, the chlorine set free being the sterilizing agent. Parfitt[3] strongly recommends paraform, on the grounds (1) that the formaldehyde which it gives off never rises to such a degree as to cause irritation of the soft tissue, and (2) that its action is continuous. About half a grain mixed with a fluid is made into a paste, applied to the pulp chamber and left in position for about one week.

The second stage in treatment is to clear the pulp canals of their contents and apply a sterilizing dressing. The cavity should be prepared as far as is possible and the tooth isolated by suitable means. The cavity should then be flooded with peroxide of hydrogen. With hooked nerve extractors the canal should be carefully freed of débris, and in carrying out this part of the operation a word of caution is necessary. There is a danger of septic material being forced through the apical foramen, and to obviate this the cleansing process should gradually proceed from the orifice of the canal to the apex, sodium peroxide followed by peroxide of hydrogen being frequently introduced into the canal to sterilize the pulp tissue and prevent septic inflammation in the event of any of the pulp tissue passing through the apex. The canals should then be treated with some antiseptic solution introduced on a wisp of cotton-wool, a rotatory rather than a pumping action being employed.

The pulp tissue having been removed as far as possible, the advisability of enlarging the canals with reamers must be considered.

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[1] Equal parts of cresol and formalin.

[2] 5 per cent. solution of dichloramine-T. in chlorcosane.

[3] "Operative Dental Surgery," p. 244.

The canals should be enlarged in all cases where a septic condition exists. The dentine bordering the canal is the part most infected, and is therefore removed in the process of enlarging. An antiseptic dressing should then be sealed in the canal and left for about one week. At the next visit, if the dressing shows no signs of sepsis, the canal can be filled as described on p. 453.

Schreier has recommended a mixture of *sodium and potassium* for the treatment of septic roots. The mixture consists of two parts of sodium to one of potassium, and is used as follows: The cavity is prepared and the pulp chamber opened up so as to allow free access to the root or roots. The rubber dam should always be applied. With a warm instrument an opening is made through the wax covering the mixture. A fine broach—iridio-platinum for preference—is introduced into the preparation and withdrawn; the broach with the adherent mixture is then introduced into the canal. This step is followed by a slight hissing or explosion. One application is usually sufficient for each root, but this depends upon the amount of septic matter in the canal and the quantity of kalium-natrium introduced. "Potassium and sodium hydroxides are formed which, in combination with the fat of the pulp, form soap. A portion of the alkalies renders the albuminous substances in the canal soluble, and in this way tissue adherent to the walls is dissolved and access easily obtained to the dentinal tubes." The kalium-natrium is said to possess germicidal properties, partly by the heat set up and partly by the new product formed. The introduction of the kalium-natrium should be followed by the use of sodium or hydrogen peroxide. In practice the method yields good results, and its use is indicated in canals the contents of which are very putrid.

J. P. Buckley prefers, for the cleansing of the canals, to work carefully up the canal with phenolsulphonic acid, frequently neutralizing the acid with a solution of 10 per cent. sodium bicarbonate.

The method of sterilization suggested by Percy R. Howe[1] is based on rational lines. It aims at destroying bacterial life and filling the dentinal tubules with metallic silver. Two solutions are prepared which may be termed A and B. Solution A[2] is made from

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[1] *Journ. Nat. Dent. Assoc.*, vol. vii, p. 853.

[2] *Notes on preparation of Solution A.*—Just cover the silver nitrate crystals with water and dissolve them by the aid of heat. Add strong ammonia until the liquid almost clears, but do not allow it to become quite clear as an excess of ammonia is desirable.

Silver nitrate crystals	grm. 3
Distilled water	1 c.c.
Ammonia, 28 per cent.	2·5 c.c.

Solution B.

Formalin	1 part.
Water	3 parts.

Other solutions needed are: One consisting of rosin and alcohol, of a fairly thick consistency, and a stain remover in the form of a strong solution of iodide of potassium.

The method of procedure is as follows: The crown of the tooth and the walls of the cavity to the level of the pulp chamber are protected with a suitable varnish. The tooth cavity is filled with Solution A which is allowed to remain in position for three minutes. If the solution is taken up by the tooth, more should be applied. Solution B is next added and allowed to remain for one minute. The solutions are then removed with cotton or absorbent paper. The operation is repeated two or three times. The putrescent material in the canals is then removed and the solution re-applied. The tooth is then dried and eugenol applied, the tooth being filled with the chosen material. Finally, the solution of iodide of potassium is applied to obviate the possibility of stain from any silver solution that may remain.

Teeth treated by this method and then extracted are shown in fig. 590. Howe states that the silver does not enter sound dentinal tissue because it contains a coagulable colloid which coagulates or forms a surface silver albuminate.

Investigations into the question of root-canal sterilization are recorded by J. S. Marshall.[1] The tooth was isolated with sterilized rubber dam and the dam and tooth washed several times with 70 per cent. alcohol. Under strict aseptic conditions the canal dressing was removed and a sterile cotton dressing inserted and sealed in position. After twenty-four hours the cotton dressing was removed and examined in accordance with the usual bacteriological technique. 127 cases were examined, and of these 10 per cent. remained infected after repeated treatments; 39·4 per cent. were sterilized successfully the first time; 26·8 per cent. were infected after the first series of treatments, and 23·6 per cent. were found sterile after repeated treatments. These investigations, while demonstrating that the tissue bordering the canal can be sterilized, do not show whether the whole of the dentine was placed in a similar state.

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[1] *Journ. Nat. Dent. Assoc.,* March, 1922.

In *cases complicated with acute periodontitis* it is important to remove the contents of the canals wherever practicable, but this can seldom be carried out thoroughly. An entrance, however, should be made into the pulp chamber. If the tooth is free from caries, or a filled cavity is present, an opening should be made into the pulp cavity by the most direct route, and treatment for acute periodontitis prescribed. If a cavity exists, the pulp chamber should be opened, the contents removed, and the canal freely syringed with antiseptics. The pulp chamber should be syringed daily, and, when the inflammation has subsided, the canals should be sterilized and filled. In opening up a tooth with acute periodontitis much pain may be avoided by keeping the tooth steady.

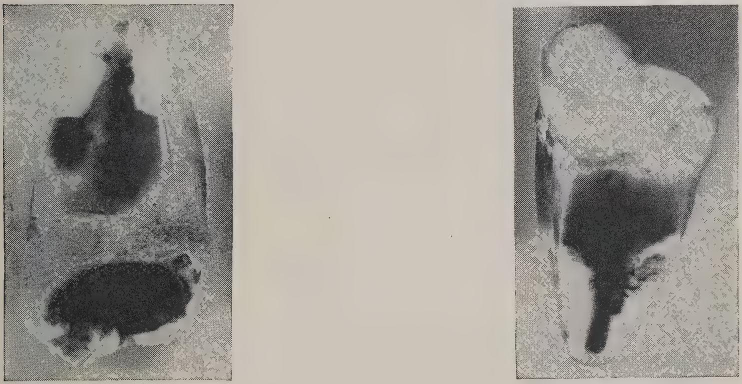

Fig. 590.

From *Journal of National Dental Association.*

In *cases complicated with suppuration around the apex of the tooth* the canal should be treated as previously described. The abscess cavity should then be opened by trephining through the alveolar process and the suppurating surface should be scraped. The abscess cavity should then be packed with an antiseptic gauze and made to heal by granulation from the bottom of the cavity.

If a sinus is present on the gum, a similar line of treatment should be adopted.

(D) METHODS OF BLEACHING TEETH

Pulpless teeth often become discoloured. In some cases the discoloration is hardly perceptible, while in others it is marked, being often of a bluish black. Teeth in which the pulp has died from the effects of injuries seem to discolour most, and the teeth of the young are more liable to be discoloured than those of adults.

The discoloration is said by some writers to be due to the passage of the colouring matter of the blood into the dentinal tubes, but until the nature of the product formed in the dentinal tubes is definitely known it is difficult to say if this view is correct. Staining of the tooth structure may also be due to the use of amalgam as a filling.

To remedy the unsightly appearance of discoloured teeth the process of bleaching is recommended. The best results are obtained with hydrogen peroxide (100 vols.). The tooth must be isolated with rubber dam. The drug is placed in the cavity on a pledget of wool and decomposed with an air-blast from the hot-air syringe. The treatment needs to be continued for about a quarter of an hour, when a small amount of hydrogen peroxide may be left in the cavity and the filling of gutta-percha or oxysulphate inserted. It is well to seal the apical foramen before applying the drug.

Where teeth are discoloured by metallic stains, little improvement can be anticipated from bleaching. In most cases it is better to remove the discoloured dentine as far as is safe, and then to fill or line the cavity with some light-coloured osteoplastic.

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CHAPTER XVI

Diseases of the Periodontal Membrane

Acute Local Periodontitis—Chronic Local Periodontitis—General Periodontitis—Regressive Changes—Necrosis of Teeth—Granulomes—Anchylosis of the Teeth to the Jaws

(A) LOCAL REACTION TO INJURY: INFLAMMATION—PERIODONTITIS

The local adaptive changes resulting from injury to the tooth membrane are generally known as "periodontitis." Two grades of inflammation may be recognized, namely, the acute and the chronic. In acute periodontitis, the development of the inflammatory processes is rapid, and is accompanied by marked clinical symptoms; in chronic periodontitis, the reaction is slow in development and the clinical signs are either very feebly marked or absent altogether.

(1) Acute Local Periodontitis

Causes.—In a few instances, acute periodontitis may arise from *traumatism*, e.g., a blow; too rapid separation of teeth preparatory to filling; the application of too much force when teeth are being regulated by mechanical appliances; or the passage of an instrument into the membrane during the treatment of the root canal. The commonest cause is injury from the *toxic products of bacteria* which may reach the membrane viâ the pulp canal or the gingival margin, a good example of the latter being seen in cases of suppuration in connection with partially erupted mandibular third molars. Injury to the membrane leading to acute periodontitis may also arise from the injudicious use of strong *chemical agents* in the treatment of the pulp canal.

Generally speaking, the reaction set up by injury from chemical agents or trauma terminates in "resolution," whilst the reaction started by the toxic products of bacteria may end in suppuration.

Morbid Anatomy and Pathology.—The primary effect of the injury is to cause a temporary contraction of the arteries, and this is succeeded by a slow but progressive arterial dilatation which eventually extends to the capillaries. The increased flow of blood to the part causes the tooth to be slightly pushed from its socket, and the result shows itself clinically by the tooth appearing to be too long. The further development of the inflammatory process consists of a slowing of the blood current accompanied by increased outflow of lymph from the vessels and migration of the leucocytes. If the injury is not of a bacterial character, the reaction may not reach beyond this stage, the stasis in the blood-vessels disappears, the fluid exudate passes into the lymphatics, the débris of any dead tissue is removed by the leucocytes and the parts return to their normal condition.

When the injury is bacterial in character, the inflammatory process is characterized by a marked attraction to the part of leucocytes of the polymorphonuclear variety accompanied by a rapid liquefaction and digestion of the tissue elements. A zone of tissue around the tooth is thus destroyed and its place is taken by a cream-like fluid, i.e., "pus." Adami[1] points out that in suppurative inflammation there is a period of incubation during which the bacteria multiply and the migration of the leucocytes to the part does not occur until after the cells of the part have become swollen and the vessels full of blood. The delay in the attraction of the leucocytes is, he thinks, due to the fact that some little time must elapse before sufficient toxins are formed by bacteria to attract the leucocytes. Clinically this is shown about the second day by the rapid development of symptoms following the onset of a septic periodontitis. The bacterial growth continues until the organism is able to offer sufficient resistance, the liquefied tissue, "pus," being walled in by a dense layer of leucocytes, and a fully developed abscess is formed. When the pus has formed it may:—

(*a*) become circumscribed, and the condition become more or less chronic; (*b*) work towards the surface and point; (*c*) burrow along the fascia and the muscles.

When the pus becomes circumscribed, the inflammatory process subsides and a zone of granulation tissue forms around the pus and encloses it. The abscess may then remain inert, but more commonly the suppuration slowly spreads and gives rise to a type of chronic abscess.

When the pus works towards the surface, it follows the direction of least resistance. It may escape at the gingival margin, but in most cases it works its way through the outer alveolar wall and points on the gum over the affected tooth. As long as the pus is confined in the bone, the muco-periosteum is only slightly œdematous, the cellular tissue of the face being unaffected. But when the pus has gained an exit through the alveolar process a rapid swelling of the cellular tissues takes place owing to a diffuse cellulitis. The extent of the swelling is determined by the virulence of the organisms producing the suppuration and by the resistance of the tissues. The abscess may discharge spontaneously, and, if the tooth or source of infection be removed, healing by granulation usually ensues. In the event of the source of infection remaining, the surface is kept constantly infected and a chronic sinus results.

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[1] "The Principles of Pathology," p. 393.

When the pus burrows along the fascia and muscles, it may lead to troublesome complications.

In the maxilla suppuration around the maxillary first and second incisors may spread into the nasal fossa. Pus from the region of the maxillary second incisors is prone to burrow under the muco-periosteum of the hard palate and form a large fluctuating swelling which usually points at the junction of the hard and the soft palate. Although this condition occurs most frequently in connection with the second incisor, it may arise from the second premolar, the first molar, or indeed any tooth in the maxilla. The pus may take a direction towards the maxillary sinus, invade this cavity and lead to suppuration. This occurs generally in connection with the second premolar or the molars, but may arise from any tooth in the maxilla. Infection from the premolars and molars may track upwards to the orbit and set up an orbital periostitis and cellulitis.

Infection around the maxillary molars may spread through the posterior dental veins to the pterygoid plexus and from the latter infection may pass by way of the emissary veins to the cavernous sinus. This type of case exhibits the following clinical features: Pain around the tooth with the signs of suppuration in the early stage; the infection spreads rapidly and the eyelids become swollen and œdematous; severe pain in the head which becomes extreme with the slightest movement; the patient loses consciousness and passes into a condition of stupor; the head is drawn to the affected side; there may be proptosis of both eyeballs, the temperature rises considerably, and there is increase in the pulse and respiration rate. The prognosis is distinctly bad. Pus around the canine may burrow upwards towards the inner canthus of the eye, and in one case seen an abscess in connection with the maxillary first premolar pointed near the angle of the mouth.

In the mandible, the pus, instead of working its way through the outer alveolar plate, may penetrate the inner side of the alveolar process and open on the floor of the mouth. From the incisors and canines, the pus, especially if it penetrates the outer alveolar plate low down, may strip up the periosteum and eventually open under the chin. The insertion of the buccinator will usually influence the direction taken by the pus. If the pus penetrates the bone outside the attachment of the buccinator, it will burrow into the tissues of the cheek, perforate the skin and open on the face. The most severe form of dento-alveolar abscess arises in connection with the molars. The pus may burrow under the masseter, or under the internal pterygoid and work among the planes of connective tissue in the neck, producing a diffuse cellulitis (angina Ludovici). The onset of the cellulitis is attended by a marked increase of the temperature; rigors often occur, and there is great prostration. There is marked œdema of the tissues forming the floor of the mouth, the mucous membrane being pushed up in such a manner that it frequently suggests a second tongue. The swelling increases rapidly over the front of the neck, spreads backwards to the parotid region, upwards to the orbit and, in the later stages, involves the thorax. There is usually œdema of the larynx. The brain may become involved by extension of phlebitis along communicating venous branches. The condition nearly always terminates fatally. A case of extreme severity which, however, terminated favourably, was recorded by A. Kendrick.[1] The trouble arose in connection with a mandibular left first molar which one year previously had been fractured. The left eye was closed, and pus escaped from the lower orbital margin and from the upper eyelid, a large sloughy opening being present in the centre of the cheek. There were several sinuses along the border of the mandible. The pus had travelled down the anterior border of the sternomastoid to the clavicle, where several sinuses opened; there was also a large sinus over the sternum. Pus had burrowed upwards along the ramus into the temporal fossa, the whole temporal region being œdematous. The tooth was removed; the temporal region was incised and the sinuses freely opened up and packed with iodoform gauze. The patient made a steady recovery.

Extensive necrosis of the maxilla or mandible may result from dento-alveolar abscess (see Chapter XXX). In severe cases general infection may occur.

Acute suppurative periodontitis may arise in connection with

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[1] *Journ. Brit. Dent. Assoc.*, October, 1900.

teeth with living pulps. The two following cases are examples.[1] A small cavity appeared on the lingual surface of the maxillary right second incisor in a girl aged 13. The pulp was exposed and a dressing of devitalizing material was applied for half an hour, when the cavity was enlarged and a fresh dressing applied. Five days afterwards the patient returned with a large dento-alveolar abscess pointing in the sulcus between the gum and the upper lip. The abscess was opened. The next day the dressing in the cavity was removed and the cavity left open to allow the abscess to drain, the assumption being that the pulp was dead. When seen five days later the abscess was apparently cured, but the pulp was found to be partially alive. It was removed and the canal filled. The second case was in connection with a maxillary left second premolar distal cavity. Remnants of pulp remained at the apices, and arsenic was applied. A mesial cavity in the first molar was prepared and a layer of softened dentine left over the pulp. A dressing of sandarac varnish was packed into the cavities to press away the gum. After two days the patient returned, and it was found that a large abscess had formed. The pulp of the molar was acutely sensitive and arsenic was applied. The root canals of both teeth were subsequently cleared and filled.

Signs and Symptoms.—In the early stage, the tooth causes the patient discomfort, is slightly raised in its socket, and pressure brings relief. At this period the blood-vessels are in a condition of hyperæmia. The tooth then becomes still further elongated and loose, the gum around it being swollen and painful. The vessels are nearing the condition of stasis, and the surrounding tissues are infiltrated with inflammatory exudation, hence the increased rising of the tooth in its socket. Pressure now increases the pain, because the vessels can no longer be freed of their surplus supply of blood. Each act of mastication under such conditions only increases the pressure on the already hypersensitive nerves. If suppuration supervenes, the swelling of the gum increases, the tooth becomes more loose and the pain dull and throbbing. Finally, a distinct fluctuating swelling appears in the sulcus between the gum and the cheek, the face swells quickly, and, the pus being no longer confined in a dense unyielding structure, the tension upon the nerve-endings is relieved and the pain considerably lessened. Suppuration is usually accompanied by pyrexia.

Diagnosis.—The diagnosis is usually easy. Where suppuration has taken place, the surrounding teeth may have become implicated in the inflammation, but the tooth causing the trouble will be looser than its neighbours and more sensitive to pressure and percussion.

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[1] Recorded by A. E. Baker, *Journ. Brit. Dent. Assoc.*, May, 1895, p. 268.

Treatment. *Local.*—The first step is to remove the cause, as far as this is practicable. If the condition is due to the passage of drugs through the apex of the tooth, the application of counter-irritants or fomentations to the gums will usually give relief. Where the injury has been caused by instruments in the treatment of the root canal, extraction is the best line of treatment.

When the periodontitis is due to bacterial toxins, the first point to decide is whether the retention of the tooth is advisable. Teeth that are unsavable by conservative operations should be removed. Where there is a possibility of retaining the tooth, the septic matter in the pulp chamber should be removed. Care should be taken in performing this operation, as such teeth are extremely sensitive. The tooth should be kept as firmly fixed as possible. Although complete removal of the septic matter is seldom practicable, an effort should always be made to gain an entrance to the pulp chamber and for this purpose a small hole should be drilled through the tooth at the neck. This can be accomplished with a sharp bur without causing much pain. The pulp chamber should be syringed with an antiseptic solution. Fomentations should be applied to the gum over the root of the tooth, or the gums may be scarified. *If suppuration has occurred*, measures must be taken to remove the pus as soon as possible. The removal of the pus may be hastened by the continued application of fomentations over the situation of the tooth, and, as soon as the pus has pointed, the abscess should be opened. The cavity should be thoroughly irrigated with some unirritating antiseptic solution and drainage provided. The abscess should be dressed at least twice a day, and this is especially needful when it occurs in the mandible, on account of the drainage difficulty. Acute dento-alveolar abscesses generally heal rapidly, especially if carefully dressed. In the case of extensive abscess, the patient must be anæsthetized, the suppurating tracts freely opened, irrigated, and packed with an antiseptic gauze; but this is a subject belonging rather to the domain of general surgery.

If the skin shows signs of being involved in the inflammatory process, it should be dressed with a compress dipped in some mild astringent solution (lotio plumbi). If the abscess threatens to open through the skin, the latter should be supported by covering the surface with a layer of cotton-wool painted over with collodion solution; by this means, aided by free opening of the abscess into the mouth, the opening on the surface can often be avoided. When an opening through the skin is unavoidable an incision should be made at the earliest opportunity, and on no account should the abscess be allowed to burst spontaneously. If this precaution is taken, much disfiguration may be avoided. The incision should follow, as far as possible, the fibres of the platysma. A cut across the fibres leaves a gaping wound, whereas when the cut is parallel with them the resulting scar is almost imperceptible.

When the patient will consent, a much better course is to open the apical space through the alveolar process. An anæsthetic having been administered, an incision is made in the gum down to the bone. The hæmorrhage is arrested, the periosteum covering the part to be penetrated is raised, and the apical space opened with a trephine on the dental engine. The cavity is then syringed and the opening packed with an antiseptic gauze.

In opening an abscess connected with a mandibular molar, care must be taken to avoid injuring the artery. In cutting, the knife should be directed towards the bone and not away from it. In opening abscesses in the palate, the anterior or posterior palatine arteries may be injured. The incisions into palatal abscesses should therefore be made, as far as possible, parallel with the course of these vessels.

As soon as the active stage of inflammation has subsided the pulp canals should be treated in the usual way. *Where suppuration is extensive* and the pus shows signs of burrowing in an unusual direction, the tooth should be removed immediately.

General.—In the early stages a smart saline purge will assist in clearing up a local periodontitis. If suppuration has taken place, the necessity of attending to the general health of the patient cannot be too strongly emphasized. The bowels should be carefully regulated, and, if needful, a tonic treatment prescribed which, in addition to drugs, should include plenty of fresh air and good wholesome nourishing diet.

(2) Chronic Local Periodontitis

(i) Commencing near the Apex of the Tooth

Causes.—Chronic periodontitis follows on injuries similar to those leading to the acute form, the difference in the reaction of the tissues being due to the lesser intensity and persistence of the injury. By far the larger number of cases arise from infection viâ the pulp canal. In a few instances, the injury may be caused by the passage of a root filling through the apical foramen. Malocclusion or excessive use may also be cited as causes.

Morbid Anatomy and Pathology.—Where the injury is of slight intensity the change which occurs consists in a proliferation of the connective tissue leading to a thickening of the membrane, the portion immediately adjacent to the tooth tissue being replaced by cemental tissue. This type of reaction is termed *proliferative periodontitis.* The process is analogous to that which occurs in a proliferative periostitis. The naked-eye appearances of the tooth are shown in fig. 591. When the inflammation is continuous and productive, the surface of the new tissue usually presents a smooth appearance, as seen in fig. 592. On the other hand, when the condition alternates between a productive and a rarefying periodontitis, an irregular outline is usually seen, as in fig. 593. Sections through the hard tissues of teeth exhibiting this condition are shown in figs. 594 and 595. It will be noted that in fig. 594 the original layer of cemental tissue is intact, and that the lacunæ of the new tissue are fairly regular, the incremental lines of Salter being well marked. These lines are situated at the junction of the laminæ. The lacunæ in the new tissue are more numerous and are also slightly larger and coarser than in normal cement.

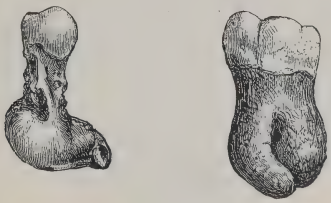


Fig. 591.

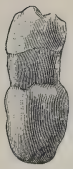


Fig. 592.

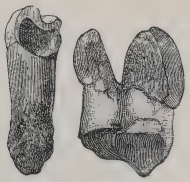


Fig. 593.

Simultaneously with the formation of the cemental tissue, a rarefying osteitis occurs, which makes room in the tooth socket for the new tissue (fig. 596). In extreme cases, two or more teeth may be the subjects of proliferative periodontitis; the intervening septum of bone may be completely removed by a rarefying osteitis and the teeth become united by cemental tissue. This occurred in the case shown in fig. 597.

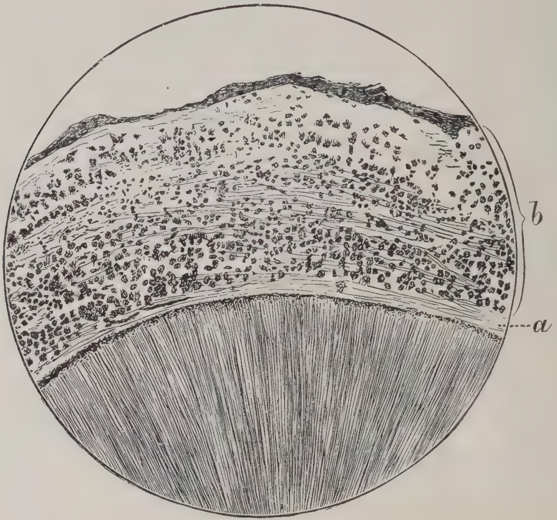


FIG. 594.—(*a*) Original layer of cement; (*b*) tissue of new formation.

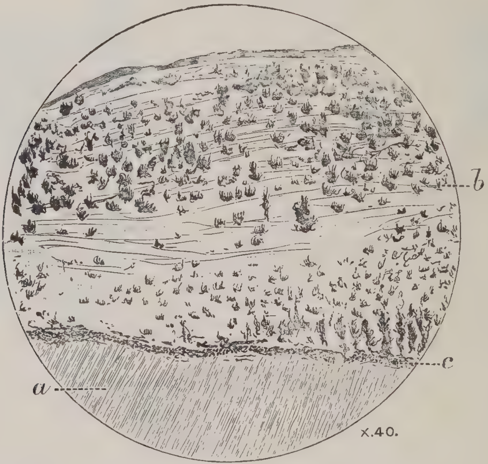
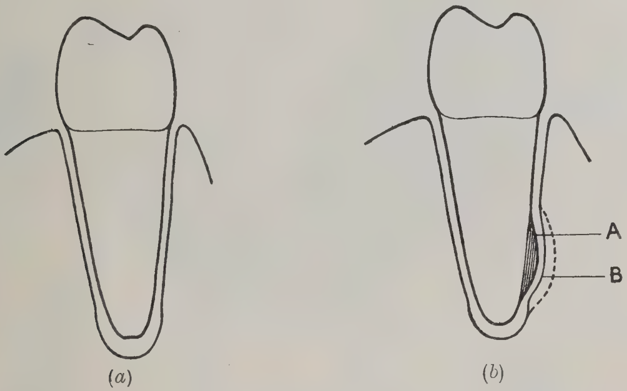


FIG. 595.—Longitudinal section showing new tissue. (*a*) dentine; (*b*) new tissue; (*c*) granular layer.

The new tissue is often more irregular in character than that shown in fig. 594, the laminæ being absent and the lacunæ placed irregularly (see fig. 598). Vascular canals are at times seen.

Adami has pointed out that substances which in larger quantities are toxic and lead to degeneration of the tissues often in smaller quantities act as direct stimuli to the cells and to increased growth; that is to say, the increased growth is not secondary to tissue destruction. Mechanical stimuli, or irritation, result in similar overgrowth.

Where the intensity of the injury is greater, the reaction in the tissues is characterized by cell infiltration of the parts in addition to the cell proliferation of the connective tissues. Among the latter are multi-nucleated cells (osteoclasts) which absorb the tooth tissue. This type of reaction is termed *rarefying periodontitis*, and the process is analogous to rarefying osteitis. A section through the tooth shows a series of semilunar excavations (Howship's lacunæ) (fig. 599).



(*a*) Showing normal relation of tooth to the alveolar process.

(*b*) Showing changes which occur in productive periodontitis. (A) new tissue; (B) zone of rarefying osteitis.

FIG. 596.

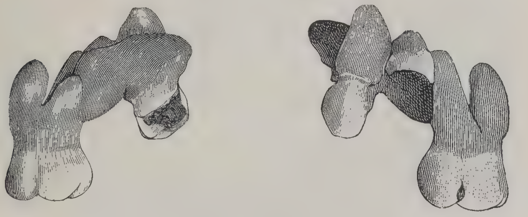


FIG. 597.

In each space a multi-nucleated cell is present, and in the neighbourhood are to be seen epithelioid cells and small cells, the appearances being in all respects similar to those seen in absorption of the deciduous teeth under normal conditions. As the absorption progresses, the cement is first removed and then the dentine, and, in rare cases, the entire root may disappear. The absorption of the teeth may take place evenly as seen in figs. 600 and 601, or in an irregular manner as seen in figs. 602 and 603. The difference

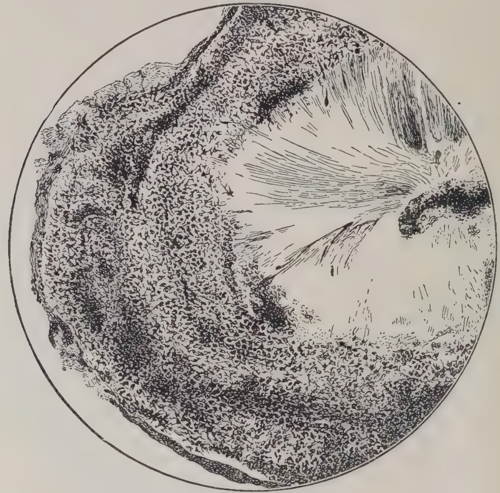


Fig. 598.—From a specimen in the possession of Douglas Caush.

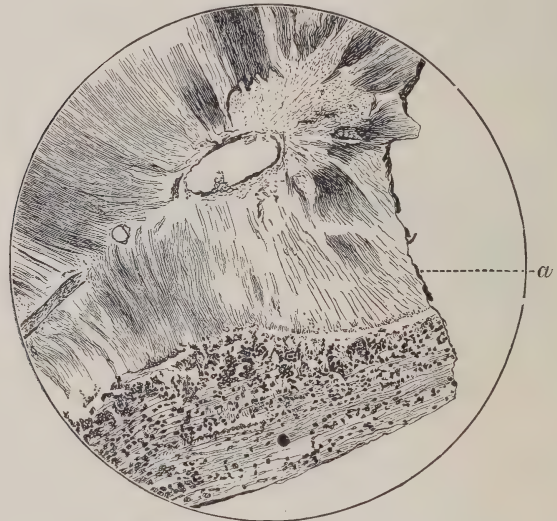


Fig. 599.—(*a*) Margin of tooth showing Howship's lacunæ. From a specimen in the possession of Douglas Caush.

probably depends upon the character of the injury and whether the injury is continuous or intermittent. Teeth showing various stages of absorption are shown in figs. 604 to 609.

Under certain conditions, e.g., the lessening in the intensity of the injury, *the rarefying periodontitis may pass into the stage of proliferative periodontitis* and much of the lost tissue may be replaced, to be, perhaps, again removed if the inflammatory process resumes greater activity. In other cases, the inflammation may cease altogether and the small-celled infiltration be replaced by cement. In the case shown in fig. 610 the dentine has been absorbed and replaced by cement. This specimen therefore indicates the existence of a rarefying periodontitis, followed by the replacement of the small-celled infiltration by cement, a condition analogous to healing in soft tissue by granulation.

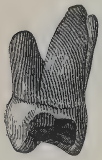


FIG. 600.

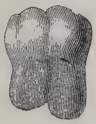


FIG. 601.

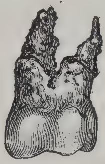


FIG. 602.

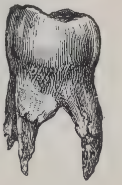


FIG. 603.

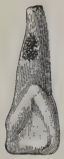


FIG. 604.

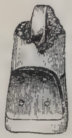


FIG. 605.

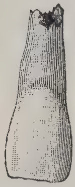


FIG. 606.

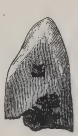


FIG. 607.

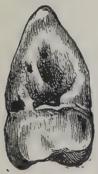


FIG. 608.—Maxillary second molar showing absorption of root due to an unerupted third molar.

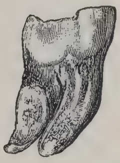


FIG. 609.—Mandibular second molar showing absorption of root due to an unerupted third molar.

In a tooth affected by rarefying periodontitis the apical portion of the pulp canal may become involved in the process and the walls

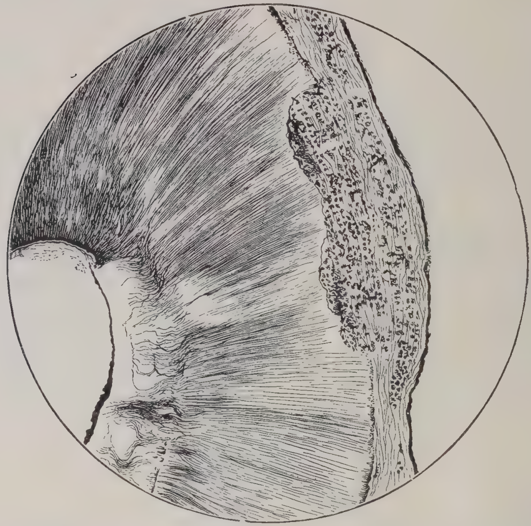


Fig. 610.—From a specimen in the possession of Douglas Caush.

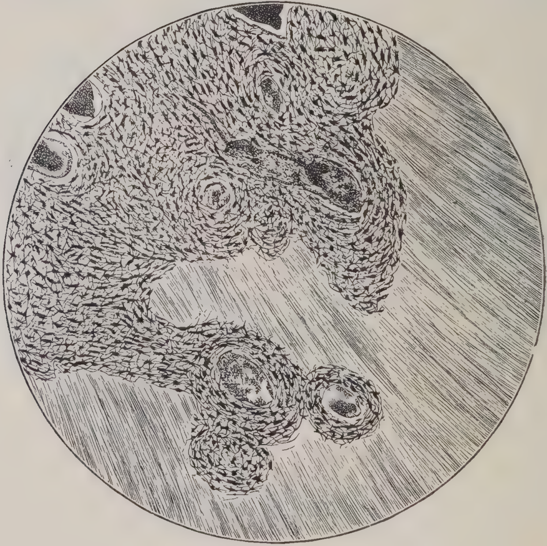


Fig. 611.—Section of a tooth showing dentine replaced by bone.

of the canal may be destroyed. If the intensity of the toxic process lessens a proliferative stage may follow and result in the deposition of cement.[1] In the section shown in fig. 611 the dentine has been replaced by bone. The tooth, a maxillary premolar, was removed from a man, aged 33 years. It erupted high up towards the outer side of the alveolar process, the root being about two-thirds formed.

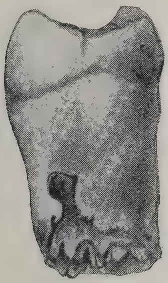


FIG. 612.[2]—View of the exterior of the tooth showing the pitted character of the end of the root with an excavation running a little way up on one side.

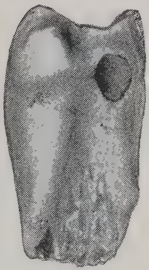


FIG. 613.[2]—View showing position of the carious cavity.

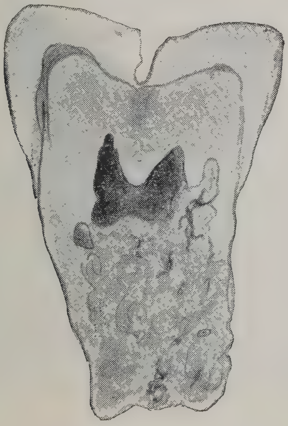


FIG. 614.[2]—Longitudinal section showing the general relation of the new tissue to the pulp cavity.

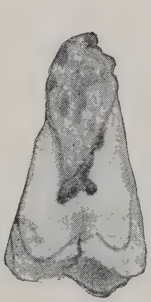


FIG. 615.[2]—View showing the extension of the new tissue upwards into the dentine by the sides of the pulp cavity.

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[1] See paper by J. Lewin Payne: "The Invasion of the Pulp Canal by Cemental Lacunæ," *Brit. Dent. Journ.*, March 15, 1921, p. 235.

[2] From *Trans. Odonto. Soc.*

In another case which came under my notice a misplaced unerupted mandibular third molar had been the seat of suppuration. In this specimen there was extensive absorption of the dentine and re-deposition of bone.

Hopewell-Smith[1] figures a maxillary first incisor, showing internal absorption of dentine and deposition of bone; and C. S. Tomes[2] records a similar condition in a maxillary premolar which had become loose. The latter tooth is shown in figs. 612 and 613, and sections showing the extent of the absorption of the dentine and replacement by bone in figs. 614 and 615.

Chronic injury to the periodontal membrane at times results in changes which are more marked in the surrounding osseous tissue than in the tooth itself. The bone in the neighbourhood of the tooth is removed and its place is taken by a mass of granulation tissue, the outer layer of which shows a tendency to fibrosis. These masses of tissue often come away with the tooth when it is extracted (see also p. 502).

When the injury persists and is of a septic or infective type suppuration ensues and produces a condition commonly known as *chronic suppurative periodontitis*. The injury usually reaches the membrane through the apical foramen, but it may pass viâ the dentine and cement from the pulp canal, Turner and Drew[3] having demonstrated bacteria in the dentinal tubes and lacunæ of the cement. The pus formed from the degeneration of the tissues may become more or less confined through being surrounded by a layer of granulation tissue, the outskirts of which show a tendency to fibrosis, and the abscess thus formed may remain stationary and give rise to no symptoms. More often, however, there is a tendency for the suppurative process to extend slowly, generally in the direction of least resistance, with the result that the alveolar process is destroyed, an opening appears on the gum, and a sinus is formed.

In discussing acute suppuration it was explained at what positions the abscess might be expected to point (see p. 463). The same positions may also be regarded as the probable sites of the pointing of chronic abscesses.

The extent of destruction of the bone which may occur in chronic suppurative periodontitis is shown in the specimens described below.

The mandible of a child about six years of age is shown in fig.

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[1] "Histology and Pathology of the Teeth."

[2] *Trans. Odonto. Soc.*, vol. xxxi, p. 172.

[3] *Proc. Roy. Soc. Med.*, vol. xii (Odonto. Sec.), pp. 104-118.

616. The bone around the apices of the anterior roots has been destroyed to such an extent as to form definite cavities; the outer aspects of the roots throughout their entire length have been denuded of bone. The destruction of bone is more marked in connection with the second than the first molar. The radiogram of the specimen, fig. 617, should be contrasted with that in fig. 618, which is taken from a normal specimen.

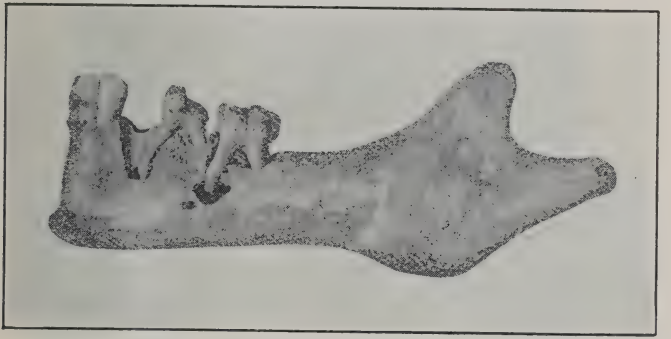

FIG. 616.[1]—Mandible showing destruction of bone around the roots of the deciduous molars.

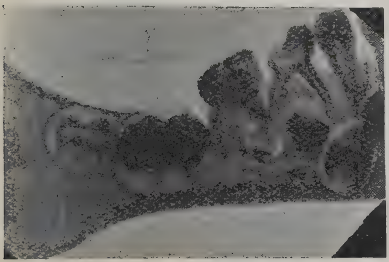

FIG. 617.

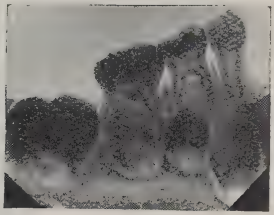

FIG. 618.

If the fleshy covering of this specimen (fig. 616) could be reinstated we should see a marked marginal gingivitis; teeth covered with food débris; sinuses opening into the sulcus between the gum and the cheek and constantly discharging pus. The child would be typical of many seen at the present time.

A less severe condition is seen in fig. 619. The mandibular right second molar has been attacked by caries, the destruction of the dentine having at the time of death just reached the pulp cavity. The bone intervening between this tooth and the first deciduous molar has been destroyed and the upper two-thirds of the anterior root has been denuded of its bony cover. There is no appearance of trouble around the apex of the root. The radiogram (fig. 620) of this specimen shows the extent of the bone destruction. It will be noticed that the crypt of the first premolar has been opened on the distal aspect and that the bony layer which should exist between the second premolar and the second molar has disappeared. Put on the covering of soft tissues and we should probably see food packed between the deciduous molars, with the anterior root of the

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[1] I am indebted to the publishers of the *Dental Record* for the blocks of figs. 616 to 636.

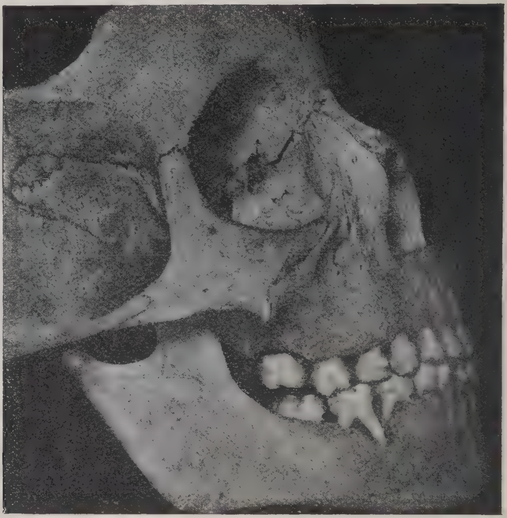

Fig. 619.—Skull and mandible of a child about six years of age, showing the effects on the bone of suppuration in connection with the mandibular right second molar.

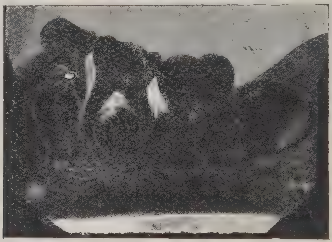

Fig. 620.—Radiogram of the specimen shown in fig. 619.

second molar partially denuded, and marked sepsis which would be in free communication with the growing premolars.

The infection may be sufficiently toxic to cause necrosis of the successional tooth as shown in fig. 621. The forward position of the first permanent molar suggests that the deciduous second molar was removed before the eruption of the permanent tooth. The second premolar presents the shrivelled appearance of a necrosed tooth.

The maxilla of a child, just over nine years of age, shown in fig. 622, demonstrates that considerable loss of bone may occur. The complete bony covering of the crown of the second premolar has been destroyed, and the posterior aspect of the socket of the first premolar has partly disappeared.

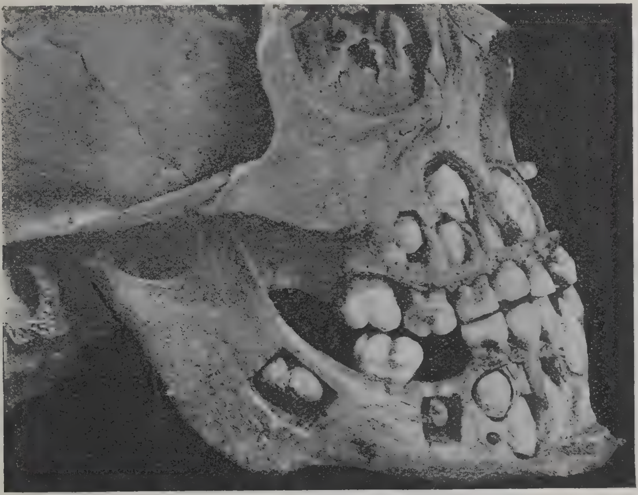

FIG. 621.—Skull and mandible of a child about seven years of age, showing necrosis of the mandibular right second premolar.

The maxillary incisors, owing to their position, are frequently injured by trauma and it is by no means uncommon to see a transverse fracture just below the neck. The root at times is left untreated, with the result that, owing to sepsis, the pulp is destroyed and infection of the periodontal membrane follows. The clinical appearances of this type of case are as follows. The tooth or teeth remaining are dark in colour; the dentine is hollowed out and is deeply stained, and there is a distinct thickening of the mucoperiosteum over the roots of the teeth. A sinus may be present and pressure over the region of the root gives rise to a definite feeling of tenderness.

The morbid anatomy of a case of this type is shown in fig. 623. It is the maxilla of an adult. The right incisors have been fractured—the second incisor through the crown near the neck of the tooth and the first incisor through the root just beyond the neck. The first incisor is little more than a hollow cone, the second incisor, on the other hand, has undergone little destruction. A well-marked cavity is present in the bone, the first incisor only retaining a connection with the bone at the posterior aspect of the root, while the second incisor has the distal and posterior aspects of its socket still intact.

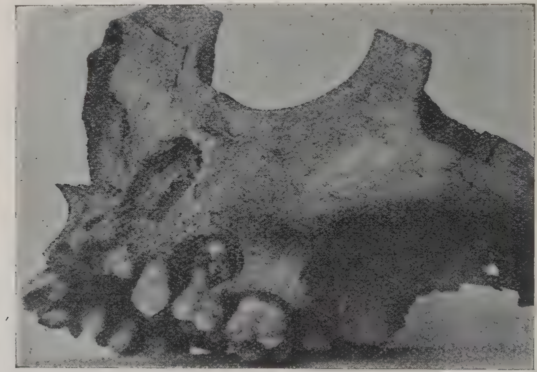

FIG. 622.—Maxillæ from a child just over nine years of age. The crypt of the left second premolar has been destroyed by suppuration.

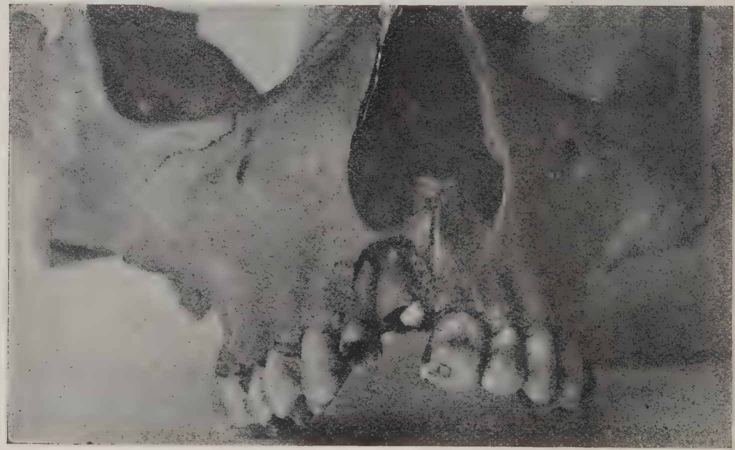

FIG. 623.—Maxillæ showing the effects of suppuration around the roots of the right incisors.

The radiogram of this specimen is shown in fig. 624.

The points to be noted are:—

(1) That there is no well-defined line between the cavity and the surrounding bone, such as is noticeable in radiograms of cysts.

(2) That there is indication of bone posterior to the roots.

A *palatal abscess arising in connection with a maxillary second incisor* is shown in fig. 626, but before considering in detail the features of the specimen a brief reference will be made to the anatomical relations of the parts involved.

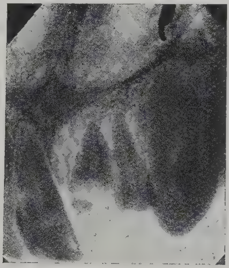

FIG. 624.—Radiogram of the specimen shown in fig. 623.

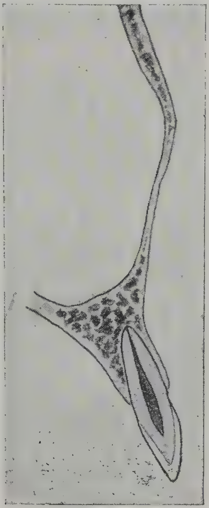

FIG. 625.—Vertical section through the maxilla in the region of the second incisor.

In fig. 625 is a diagram of a vertical section through a maxilla in the region of the second incisor. Attention is drawn particularly to the area of cancellous bone between the posterior aspect of the root and the palatal aspect of the bone. In the recent state, the palatal surface is covered by a dense layer of muco-periosteum. An abscess that appears on the palate must therefore excavate its way through this area of bone, and when it does emerge through the bone will meet with the muco-periosteum which is sufficiently resistant to stop actual penetration, with the result that the pus, following a line of least resistance, burrows under the muco-periosteum in a direction towards the back of the palate.

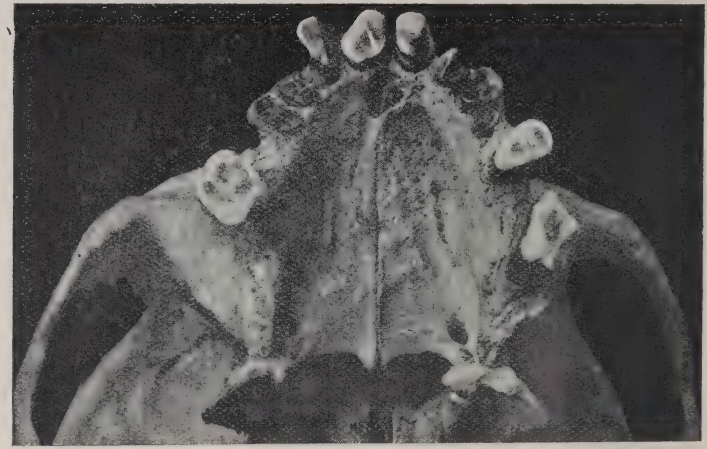

Fig. 626.—Palatal view of an abscess arising in connection with a second incisor.

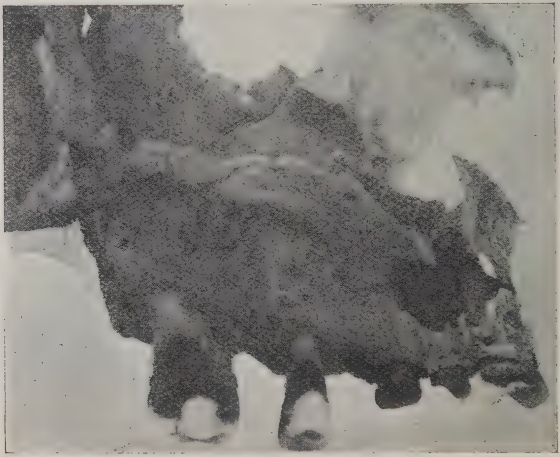

Fig. 627.—Side view of a specimen showing bone destruction in connection with a second incisor.

In the specimen, figs. 626 and 627, the pulp of the first incisor has been exposed by attrition, an abscess has formed around the apex of the root and has then made its way through the outer alveolar plate. The second incisor which shows marked attrition has been attacked by caries and the suppuration of the pulp has been followed by infection of the bone. The destruction of the bone has laid bare the whole of the roots of the incisors and the upper aspect of the mesial surface of the canine root. Extending backwards, the abscess has at one place completely destroyed the bone forming the palatal surface, so that one opening exists near the anterior palatine foramen. In its forward extension the abscess has opened into the cavity previously formed around the first incisor and by this means there is a free communication through the outer alveolar plate. The radiogram of this specimen is seen in fig. 628.

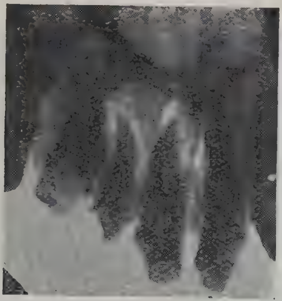

FIG. 628.—Radiogram of specimen shown in fig. 627.

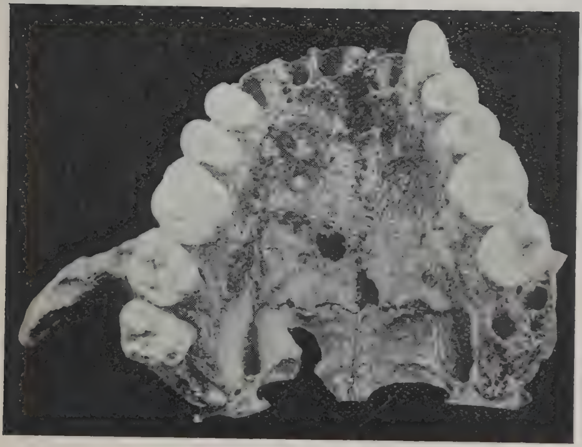

FIG. 629.—Palatal view of a dento-alveolar abscess encroaching on the nasal fossa.

This type of case would present the well-recognized clinical features of a palatal abscess. There would be a swelling in the palate, with a bulging of the tissues over the anterior aspect of the tooth and definite fluctuation between the two surfaces.

The encroachment upon the nasal fossa of a dento-alveolar abscess in connection with the incisors is shown in fig. 629. The teeth were all present at the time of death with the exception of the left first incisor. Viewed from the palatal aspect there is a slight elevation of the bone on the right side, the elevation extending from the anterior teeth to the suture between the maxilla and the palate bone. About 6 mm. from this suture and close to the median line there is an opening communicating with a large abscess cavity. The margins of the opening are irregular and the surrounding bone thin and porous. Viewed from the nasal aspect it will be observed that the bone forming the floor of the left nasal fossa has been pushed upwards and partly destroyed, so that a clear view is obtained of the abscess cavity, which measures roughly

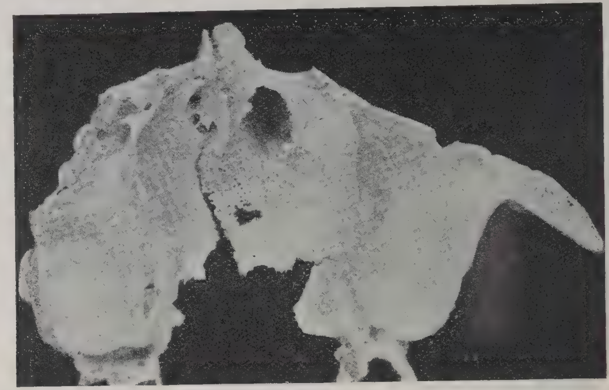

Fig. 630.—Nasal aspect of the maxilla shown in fig. 629.

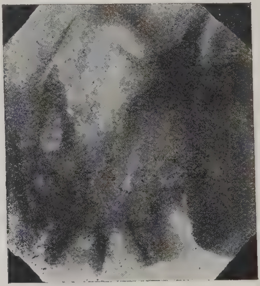

Fig. 631.—Radiogram of the specimen shown in figs. 629 and 630.

25 mm. by 15 mm. The sockets of the right incisors and canine open into the cavity.

The absence of the left first incisor was probably traceable to trauma and it is possible that the right incisors were injured at the same time, resulting in septic infection of the pulps. The abscess, as it increased in size, gradually destroyed the cancellous tissue and then, burrowing towards the root of the nasal process, gradually pushed up the bone forming the floor of the anterior nares and the internal aspect of the nasal process and completely blocked the anterior nares.

A radiogram of the specimen is shown in fig. 631.

A dento-alveolar abscess in connection with the maxillary canine usually opens through the anterior alveolar plate about the region of the apex of the tooth. More rarely the pus will track towards the nasal fossa and, discharging into that cavity, give rise to a persistent unilateral nasal discharge. A specimen illustrating this latter condition is shown in fig. 632. Above the right canine there is a large excavation in the bone. The cavity is oval in shape and has been formed at the expense of the nasal process, the bone at one place being perforated so that the abscess cavity and the nasal fossa are connected.

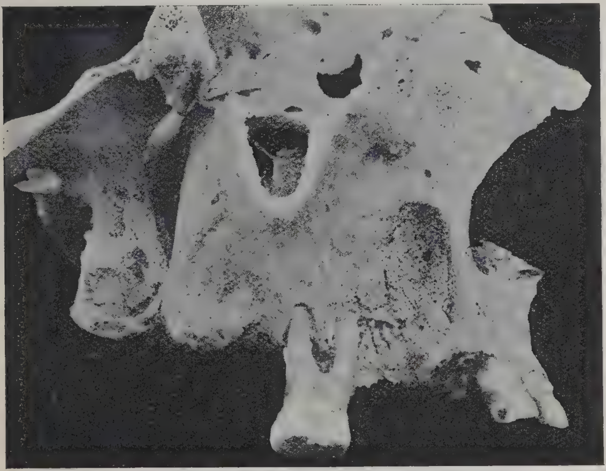

Fig. 632.—Specimen showing bone destruction in connection with the right canine. The abscess has opened into the nasal fossa.

The extensive destruction of bone that may occur around the roots of premolars is shown in figs. 633 and 634. The teeth have been robbed of their bony surroundings except on the lower half of their palatal aspects, the destruction of the bone being especially noticeable in the region of the apices. If the teeth are alone removed, the healing is considerably delayed; on the other hand, if the bridge of bone holding them is also taken away free drainage is obtained and rapid healing of the wound follows.

In the mandible, the abscess is generally more restricted owing to the denser character of the bone, but very extensive excavation of the bone is occasionally seen. With the extension of the suppuration, fresh bone is deposited by the periosteum, and, in this manner, the mandible may become considerably expanded.

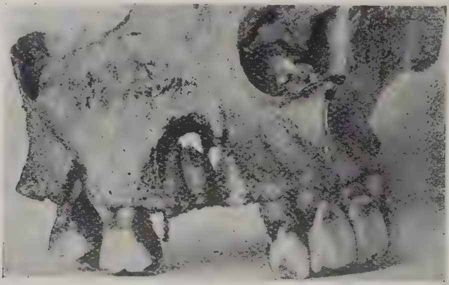

Fig. 633.—In this specimen there has been extensive bone destruction in connection with the premolars. View from the buccal aspect.

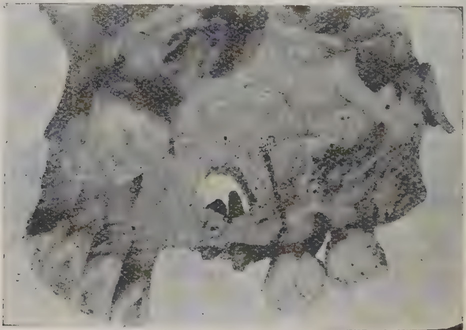

Fig. 634.—Palatal view of the specimen shown in fig. 633.

The morbid anatomy of a case of chronic suppuration around a partially erupted mandibular third molar is shown in figs. 635 and 636. An examination of the specimen points to the condition having existed shortly before death, and it is just possible that death was due to septic poisoning from the mouth condition. A view of the inner aspect of the bone shows a deep cavity extending into the body of the bone to a point just below the level of the mandibular

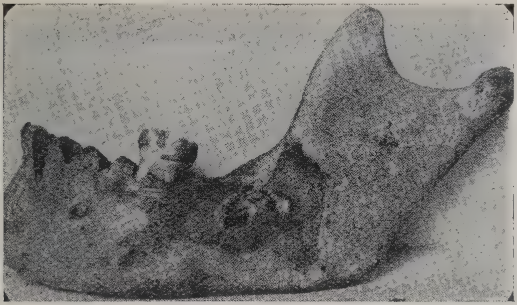

FIG. 635.—Mandible showing osteitis in connection with a mandibular molar.

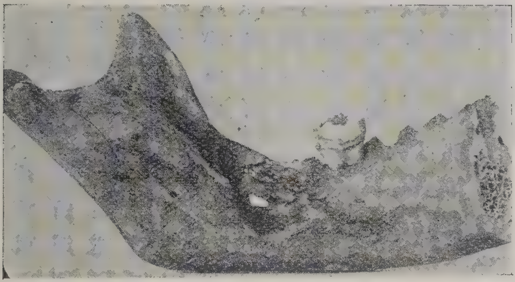

FIG. 636.—View of the internal aspect of the specimen in fig. 635, showing destruction of bone from suppuration around the third molar.

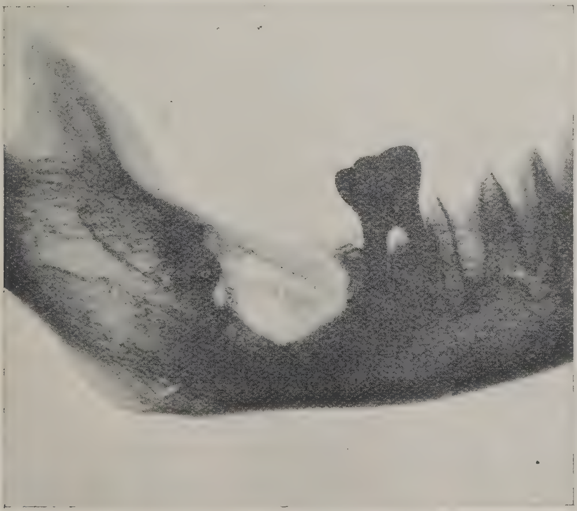

FIG. 637.—Radiogram of the specimen shown in fig. 636.

canal which has been destroyed leaving the nerve freely exposed. The external aspect of the bone shows a definite deposit of fresh bone which in the centre is pierced by an opening leading to the tooth socket. The radiogram (fig. 637) shows clearly the extent of the bone excavation and brings out the relation of the cavity to the mandibular canal. (Reference to excavation of bone by cysts is dealt with on p. 616.)

In the process of suppuration, the periodontal membrane may be destroyed, leading to necrosis of the cement.

A somewhat rare form of abscess[1] which occurs in the jaws may be described under this heading, as it is in reality a sequel to suppurative periodontitis. The abscess may be caused by the presence of a small piece of root in conjunction with insufficient drainage after the extraction of septic teeth. J. G. Turner has drawn attention to this type of abscess. He describes the symptoms as follows: " When the abscess occurs in the maxilla there is pain and tenderness, some swelling of soft parts, but no bony enlargement; the trouble may subside and occur again at intervals. If untreated the antrum may be involved. The nearest lymphatic glands may be enlarged. In the mandible, as in the maxilla, the alveolar process may be entirely absorbed, and there is pain and tenderness and some local swelling. Owing to the position of the inferior dental nerve there is often, especially in the premolar region, severe neuralgia. As in the maxilla, the nearest lymphatic gland may be enlarged and tender. The neuralgia is caused by the abscess, in its enlargement, opening up the canal of the nerve. Under these conditions there is very severe, continuous, heavy pain, and the more acute shooting pain which occurs at intervals without any necessary regularity; it is set up by any irritation, such as cold air, movement of eating, &c.; it spreads in anatomical order to the other branches of the fifth nerve, first to the ear and then up the side of the ear to the vertex, to the infra-orbital nerve, to the supra-orbital nerve, and down the neck. It lasts a varying time, from a few seconds to hours. It is unaccompanied by trophic changes, but there may be increased secretion of tears or saliva. It is confined to the one side, and appears always to start from the seat of mischief. If the abscess has not involved the inferior dental nerve, the neuralgia will be absent."

" The length of time during which things may lie dormant varies greatly; when, therefore, a patient complains of pain or neuralgia starting in a spot where there is now no tooth, there may yet be a chronic abscess, and the alveolar process may be normally absorbed.''

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[1] *Journn. Brit. Dent. Assoc.*, p. 551, 1899.

Signs and Symptoms.—Where the injury is slight and leads to a *proliferative periodontitis*, symptoms are often absent and, when present, seldom amount to more than a slight tenderness on percussion and, occasionally, attacks of pain of a dull, gnawing character. *When the inflammatory process is of a rarefying type*, the principal symptom will be slight pain and tenderness on percussion, and, if the inflammation is near the apex and the pulp is alive, there will usually be signs of pulpitis through extension of the disease to the pulp. The gum covering the tooth may be swollen. As the tooth substance disappears, increased looseness will be noticeable, the tooth becoming more tender and the pulp and the gum more congested. In cases of doubt a radiogram should be obtained.

A chronic suppurative periodontitis accompanied by a sinus will exhibit very few symptoms. Frequently the tooth causes no pain and the patient complains only of the presence of the " gumboil " which periodically swells and bursts. The sinus is usually situated over the root of the tooth. In cases of sinus on the face, some little difficulty may be experienced in tracing the offending tooth, especially if two or three teeth are pulpless or septic. A digital examination of the sulcus will often disclose a fibrous-like cord running from the base of the root to the cheek. The root or tooth causing the trouble may be buried in the gum. A sinus in the mouth in connection with suppurative periodontitis must be diagnosed from sinuses connected with necrosed bone or foreign bodies. In cases of doubt, a radiogram will prove useful. When the sinus is on the face it should be diagnosed not only from cases due to necrosed bone or foreign bodies, but also from salivary fistula.

When a sinus is not present (*chronic dento-alveolar abscess*) the tooth is usually slightly tender to percussion, the amount of pain varying according to the activity of the inflammation. The gum over the root of the tooth is at times swollen and congested, but may be quite normal. A swelling can, as a rule, be felt well up over the apex of the tooth; this swelling is usually sensitive. In cases in which the maxilla or mandible are much involved, there is often little or no pain or tenderness. A chronic dento-alveolar abscess must be diagnosed from dental cysts and other fluid swellings of the jaws (see Chapter XXXIII).

Treatment.—The treatment of chronic periodontitis must depend upon the cause. Where the pulp is living and the condition is traceable to overstrain of mastication, relief can be obtained by "freeing the bite," and applying counter-irritants to the gum.

When the chronic periodontitis is traceable to infection from the pulp canal the first question which demands attention is whether the retention of the tooth is advisable. A radiogram should be obtained and, if there are no signs of rarefying osteitis an endeavour may be made to save the tooth by sterilizing the tooth tissue through the pulp canal; if this is not feasible the tooth should be removed. In the case of septic teeth associated with rarefying osteitis, thorough sterilization of the canals will often be followed by the closing of a sinus, if it exists, and the subsidence of symptoms. Such teeth, although apparently cured, frequently remain a source of infection which may easily be overlooked, and extraction of the tooth is the safer line of treatment. Knowledge acquired in recent years has emphasized the dangers of dental sepsis, and as a consequence our views as to treatment have been modified in the direction of removing septic teeth which we should formerly have endeavoured to retain. Sinuses in the mouth connected with septic teeth usually heal rapidly when the teeth are removed. Sinuses on the face or neck are sometimes slow in healing, and it may be necessary to stimulate the track with 10 per cent. solution of nitrate of silver, or a drug possessing a similar action. If this treatment fails, an anæsthetic should be given and the surface of the track scraped. Where a cavity exists in the bone over the tooth, the sinus should be opened up and the cavity scraped and packed to assist healing. Difficulty is sometimes experienced in the healing of palatal abscesses, and when this is the case a free excision of the mucoperiosteum which covers them will often prove to be a satisfactory procedure.

A depressed scar on the face may result from the healing of a sinus. In order to lessen the deformity, the attachment of the scar to the bone should be freed and a plate inserted until a sulcus is established. Should further treatment be desirable, the scar should be excised and the edges of the wound sutured with horsehair ligatures.

Streptothrix Infection.—Streptothrix infection in connection with the lesions of the teeth may be conveniently dealt with under "Chronic Local Periodontitis," inasmuch as the infection often takes place viâ the periodontal membrane.

Streptothrix infection in connection with lesions of the teeth may involve the bone itself or the soft parts, the latter condition being more usually met with.

Clinical Features.—When the soft parts are involved a swelling appears, and gradually increases in size. At first the swelling has a regular and even surface, with the skin slightly hyperæmic. As the disease progresses, the tissue at places softens and nodular excrescences appear of a yellowish colour; these burst, giving exit to a semi-glutinous fluid in which the characteristic nodules of actinomycosis can be seen. The nodules vary in colour, being yellowish, yellowish-white, or quite clear. The wound generally heals and is followed by a fresh breaking out at another spot. The cicatrization following the repetition of this phenomenon gives the surface a curious puckered appearance which is characteristic of this disease. If left untreated the disease spreads to the tissues of the neck, and in some cases passes upwards to the temporal region. The sinuses formed by the breaking down of the tissue may persist and a probe passed down them will often show that they lead to bare bone, but not necrosed bone. The swelling is of a hard, brawny nature, and fades away gradually into the unaffected tissue. The disease is not accompanied by a rise in temperature, and there is usually no pain. Should acute suppuration supervene, the general symptoms of an ordinary septic abscess appear. The lymph-glands are not enlarged unless secondary infection occurs.

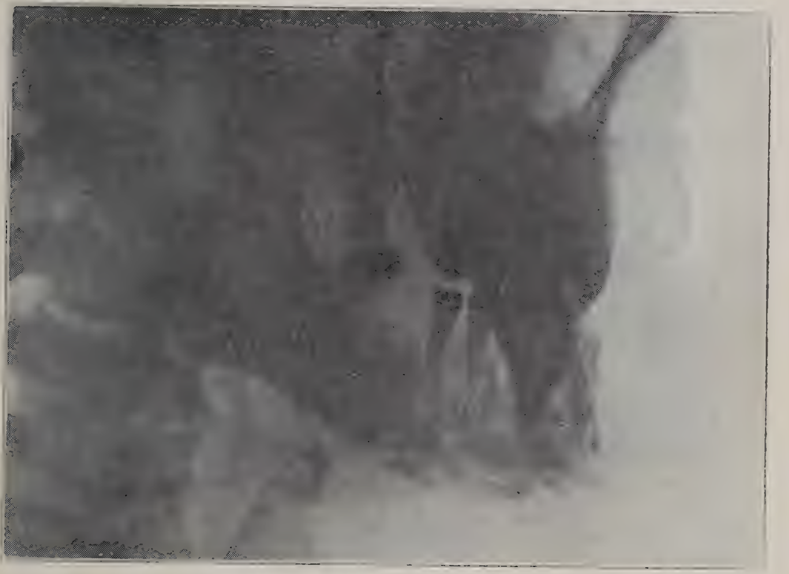

Fig. 638.

The clinical features of streptothrix infection of the bone simulate necrosis. In the majority of cases there is a history of an acute onset of symptoms; the gums become swollen and bleed readily; the teeth loosen; and there is considerable swelling of the tissues covering the body of the bone. With the progress of the disease the infection spreads along the medullary cavity, clinically expressed by a well-defined edge to the swelling. Eventually the teeth are lost and portions of the bone exfoliate.

Radiograms show the characteristic appearance as seen in fig. 638. An idea of the morbid anatomy of the condition can be gleaned from the mandible of a wild boar affected with streptothrix infection shown in fig. 639.

Diagnosis.—Streptothrix infection can be differentiated from dento-alveolar abscess by the hard, brawny character of the swelling; the long duration of the disease compared with that of a dento-alveolar abscess, and by the presence of the multiple sinuses or the puckered cicatrix, the latter being almost pathognomonic. From tubercle it may be differentiated by the fact that in tubercle the glands are usually affected, and the swelling is generally well-defined and movable. From necrosis of the jaw it may be diagnosed by the presence of bare and not necrosed bone. The presence of granules in the discharge and the demonstration of the streptothrix on microscopical examination are positive evidence.

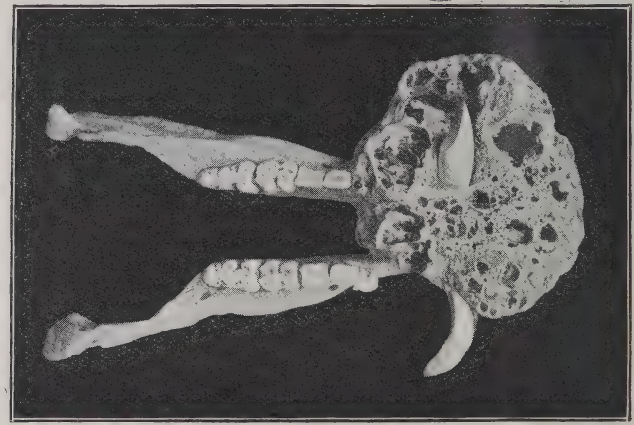

FIG. 639.

Pathology.—The disease is due to the presence of a form of streptothrix in the tissues, but the ray fungus of Bollinger (*Streptothrix bovis communis*) is an uncommon cause of human infection. The lesion produced by the growth of the streptothrix is of a chronic inflammatory character. A section through the affected tissue shows a number of rounded areas, in the centre of which is the streptothrix surrounded by a zone of granulation tissue. The tissue breaks down, and the streptothrix is expelled in the discharge. It is becoming more and more apparent that the relation of streptothricæ to disease is of considerable importance. A. G. Foulerton[1] has identified several species in man.

Method of Infection.—The infection is generally held to be conveyed by straw, cereals, &c. The parasite probably gains an entrance to the tissue viâ the periodontal membrane, and thence spreads to the neighbouring soft tissue. In specimens of actinomycosis in oxen the invasion of the tissue viâ the periodontal membrane can often be demonstrated.

Treatment.—Locally the softened spots must be incised and freely scraped and the sinus packed with iodoform gauze. Internally, iodide of potassium must be administered in doses increasing up to 50 or 60 gr. three times a day. It is also useful to add 3 to 4 minims of liquor arsenicalis, as this assists in preventing the skin lesions; it is also considered by Kellock[2] to have some effect on the disease itself.

When the bone is involved, the teeth implicated in the affected area must be removed and free drainage established, combined with the administration of potassium iodide. Recovery is usually slow.

The prognosis is good, but the treatment may have to be carried out continuously for a long period.

(ii) Commencing at the Gingival Margin

When commencing at the gingival margin, chronic local periodontitis is always due to trauma, such as the injudicious use of ligatures, elastic bands or mechanical contrivances in regulating teeth; the too rapid separation of teeth for filling; collection of food débris in the approximal space.

Morbid Anatomy and Pathology.—The whole of the periodontal membrane of the tooth may be attacked. This occurs when the irritant is a retained ligature or an elastic band. The gum around the tooth is swollen, congested and painful and the inflammation spreads to the periodontal membrane. By a process of ulceration, the membrane is gradually destroyed, the root laid bare, and in time the apical vessels are involved, leading to pulp complications. The disease may be partial, i.e., the periodontal membrane on one side of the tooth only may be attacked. This condition is seen in the mandibular incisors on the labial aspects, where the membrane is occasionally destroyed to the apex of the root. The most important form from a clinical point of view is that met with in the region of the premolars and molars. A space may exist between the posterior teeth, with the result that food becomes wedged between the teeth during mastication. The lateral pressure thus caused starts chronic periodontal inflammation which, in time, leads to the destruction of the tissue, and the condition, if not treated, will gradually involve the membrane up to the apex of the root. In other cases, the teeth may approximate at the occluding surfaces, but, owing to a slight recession of the gum, food works its way between the approximal spaces during mastication. Unless these particles of food are completely removed a progressive ulceration of the periodontal membrane is started. The membrane is destroyed in a cup-shaped manner, as seen in the diagram (fig. 640), forming pockets, the gum apparently filling up the approximal spaces (fig. 641).

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[1] *Lancet*, March 15, 1910, p. 626.

See also:—

Foulerton, A. G. R. "Streptothrix Infection," *Lancet*, February 8, 1913, p. 381.

Cope, V. Zachary. "Actinomycosis considered specially in its Relationship to the Jaws," *Brit. Dent. Journ.*, vol. xli, p. 649.

[2] "Actinomycosis of the Mouth and Face," *Trans. Odonto. Soc.*, vol. xxxvii, p. 29, 1904.

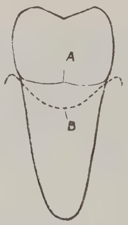

FIG. 640.—(A) neck of tooth and normal attachment of gum; (B) margin of gum.

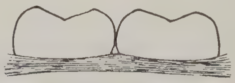

FIG. 641.

The destruction of the membrane proceeds until the apical vessels are involved and pathological processes are then started in the pulp.

In practice a curious condition is met with in which the internal aspect of the palatine root of a maxillary molar is denuded of its socket. An examination of the root will frequently demonstrate a mass of calculus around the apex of the offending root in addition to a well-marked space between the tooth and its neighbour. The pathology of this condition is not clear. An early stage is shown in fig. 642. In this specimen the jaw is well developed, the teeth are free from caries and are arranged in a good arch; there is a slight general destruction of the alveolar process, a deposit of dark calculus around the necks of the teeth on the palatine aspects and a fair deposit of lighter coloured calculus on the buccal aspects of all the teeth. In the region between the right second premolar and the first molar there is a cavity in the bone; the tissue that has disappeared comprises the septum between the teeth and the anterior and internal aspects of the socket of the palatine root. On the apical portion of this root there is an irregular deposit of hard dark calculus. The surface of the cavity is regular and smooth, suggesting that the cavity is the result of a slow, but constant, excavation.

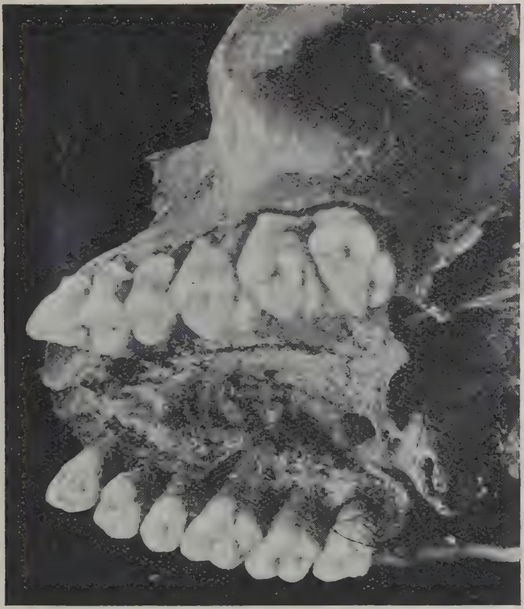

Fig. 642.—A specimen showing destruction of bone around the palatine root of the right first molar.

From *Dental Record*.

A more alvanced condition is illustrated in fig. 643. Here the process of excavation has extended so as to expose almost the entire palatine root. The edge of the cavity is smooth and regular, indicating, as in the previous specimen, that the destructive action has been slow, but constant.

In both the specimens the destruction of bone appears to have commenced in the interval between the second premolar and the first molar, and this would suggest that the primary cause of the lesion was probably a retained portion of a deciduous tooth, which had formed a stagnation area, the infection gradually involving the adjacent teeth.

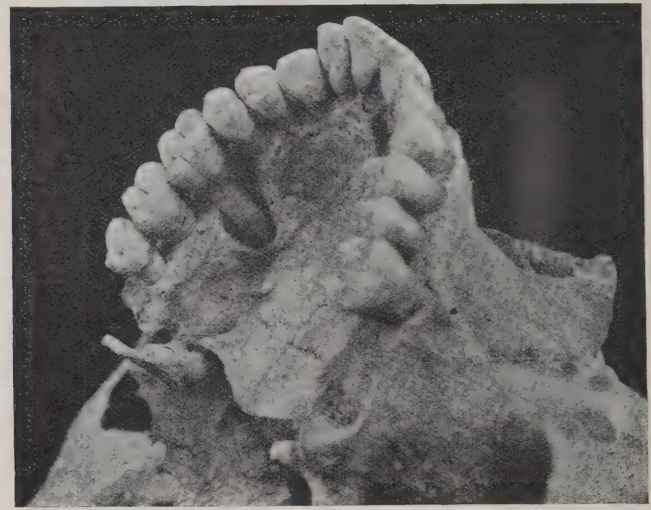

Fig. 643.—A specimen showing extensive destruction of bone around the palatine root of a right maxillary first molar.
From *Dental Record.*

Inflammatory processes around the neck of the tooth occasionally cause rapid destruction of the tooth tissue and the formation of definite cavities. The teeth shown in fig. 644 were removed from a young man who had been injured in an aeroplane. The canine and first premolar had been driven into the bone and only the occluding surfaces of the teeth were showing. They had been in this position for nearly six weeks. On the palatine aspect of the premolar there was a cavity which had spread slightly upwards under the enamel, and examination with a magnifying glass showed that it was due to absorption of the tissues. A similar but smaller cavity was found on the canine on the distal aspect.

A case in which the absorption was extensive is shown in fig. 645. Here, in a mandibular canine, the tooth tissue with the exception of that around the pulp canal had been lost by the process of absorption. There is no doubt that some of the cavities around the cervical region are produced in this way and are not the result of caries. The pathology of the condition is not clear, but it is reasonable to think that the condition is due to inflammatory reaction in the periodontal membrane.

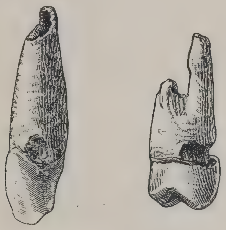

FIG. 644.

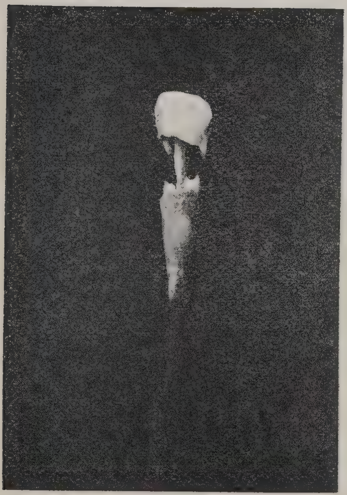

FIG. 645.[1]

Signs and Symptoms.—Slight tenderness during mastication, with pulp pain from thermal changes (owing to exposure of the cement), are the chief symptoms. *In cases due to ligatures or elastic bands*, the gum shows signs of inflammation and pus can usually be squeezed up round the neck of the tooth. There is pain to thermal changes. *In cases due to pressure from mastication* there is extreme tenderness, the gum is swollen and congested and the tooth is tender to pressure.

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[1] From *Trans. Odonto. Soc.*

When a pocket exists and the occluding surfaces are in contact, the tags of gum on the labial and palatal aspects of the approximal space appear slightly congested, but the recession from the space is, in many cases, only slightly marked. The patient complains of slight discomfort from food becoming wedged between the teeth and, if there is pain to thermal changes, an examination with a suitable probe will show a considerable destruction of the periodontal membrane, the root of the tooth being frequently denuded to the extent of at least half its length.

When a pocket occurs between the maxillary molars there is often a tender area over the region of the malar bone.

The diagnosis presents little difficulty. An inflamed condition of the gum; slight tenderness on percussion and pain on touching the exposed cement are sufficient evidence. Care must, however, be taken to exclude pulp irritation from other causes.

Treatment.—*In cases arising from ligatures, elastic bands, calculus, &c.*, the cause must necessarily be removed. The socket is then syringed with a suitable antiseptic (hydrogen peroxide, 10 vols.) and the ulcerated surface treated with some mild escharotic, such as trichloracetic acid (25 per cent. solution).

In cases due to pressure from mastication, careful contour fillings must be made in the approximal surfaces of the teeth (see p. 392) and the exposed cement treated with nitrate of silver. When the periodontitis is *traceable to the lodgment of food solely*, and is not due to pressure from mastication, the approximal space should be syringed and the surface of the gum cauterized with nitrate of silver. This drug will serve a double purpose, namely, reduce the sensitiveness of the cement and at the same time promote the formation of healthy granulations in the approximal space. The application by the patient of tincture of iodine every day for a week will result in the disappearance of the pocket and the formation of a space which can be easily kept free from food débris.

(3) General Periodontitis

Acute.—In this condition the morbid process involves several teeth as well as the contiguous periosteum of the bone. A general inflammation of the whole alveolar periosteum has therefore to be dealt with. The condition may have its origin in the periodontal membrane or in the muco-periosteum. The teeth become loose and sensitive to touch. The muco-periosteum is swollen, deeply congested and painful to pressure. The inflammation may resolve, but suppuration is very likely to occur unless prompt measures are taken to relieve the congestion. If suppuration occurs, the periosteum becomes separated from the bone, with the result that necrosis supervenes. The inflammation occasionally passes into a chronic form.

Causes.—General periodontitis may arise in persons exposed to the fumes of phosphorus (see Necrosis of the Jaws). The prolonged administration of mercury and certain other drugs may be cited as a cause. It may arise from injury in patients who are the subjects of syphilis, or may follow on one of the exanthematous fevers.

Signs and Symptoms.—The local signs and symptoms are similar to those of the local form, except, of course, that several teeth are involved in the process. Pain of a dull, gnawing character is present, and there will be general symptoms of pyrexia. Suppuration, if it occurs, is usually ushered in by a well-marked rigor, and the local pain becomes of a throbbing character.

Treatment.—*Local.*—The application of fomentations with scarification. The mouth should be kept as aseptic as possible.

The *general* treatment will depend upon the cause. A smart saline purge should be administered in nearly all cases. If due to syphilis, iodide of potassium must be given, while cases of gouty and rheumatic origin call for the general treatment of those affections. If the inflammation shows a tendency to suppurate, free incisions must be made down to the bone, followed by the constant use of fomentations.

Chronic.—There is reason to believe that the periodontal membrane may be affected by toxins circulating in the blood-stream. Occasionally there is a thickening of the cement on the teeth with no evidence of infection from the gingival margin. The following case illustrates this condition: A female aged 35 complained of indefinite pains about the head and a general feeling of ill-health. There was a history of nasal trouble. The gums were perfectly normal and there were no signs of infection around the necks of the teeth. On percussion, several of the teeth were tender. Radiograms showed a definite thickening of the roots of the teeth, more especially the premolars and molars. Several of the teeth were removed with no relief to the general symptoms. The nasal condition was treated and relieved. Signs of chronic arthritis subsequently developed and further radiograms showed an increase in the cement of the remaining teeth. The chronic periodontitis would here seem to be due to a cause acting through the blood-stream.

(B) REGRESSIVE CHANGES

The periodontal membrane of elderly persons is at times subject to regressive changes of a fibroid character,[1] which may also occur in persons of less mature years. The normal elements of the parts are replaced by fibrous tissue which is grouped together in bundles enclosing areolar spaces (figs. 646 and 647). The adjacent bone shows signs of atrophy and the gingival tissue in the immediate neighbourhood also shares in the changes by becoming less vascular and more fibroid in character.

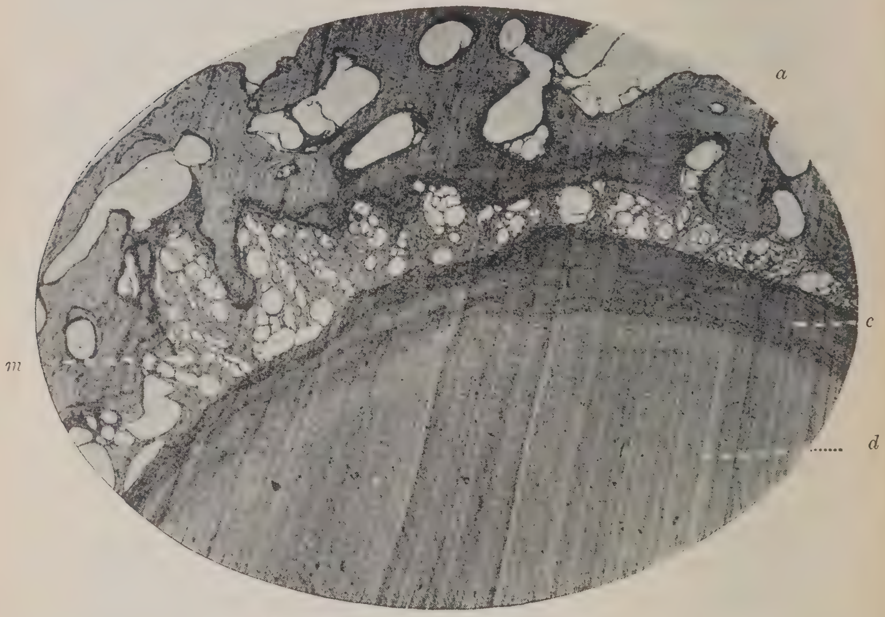

Fig. 646.[2]—(Hopewell-Smith). Transverse section of fibrosis of the periodontal membrane, *in situ*. × 50. (*d*) dentine; (*c*) cement; (*a*) alveolar bone; (*m*) fibroid periodontal membrane; devoid of cellular elements and vascular and nervous systems.

(C) NECROSIS OF THE TEETH

A tooth derives its nutritional supply from two sources, namely, the pulp and the periosteum. When the death of the pulp alone occurs, a *partial necrosis of the dentine takes place*. From a clinical point of view, this is unimportant and does not give rise to any symptoms if the canal is properly treated. When, in addition to death of the pulp, the periodontal membrane becomes separated from the cement, partial or complete necrosis of the tooth takes place. *Partial necrosis of the cement* is common and is generally the result of suppurative periodontitis. When there is *complete necrosis of the cement*, the tooth acts as a foreign body.

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[1] See paper by A. Hopewell-Smith, *Dental Cosmos*, vol. xlvi, p. 261.

[2] From *Dental Cosmos*.

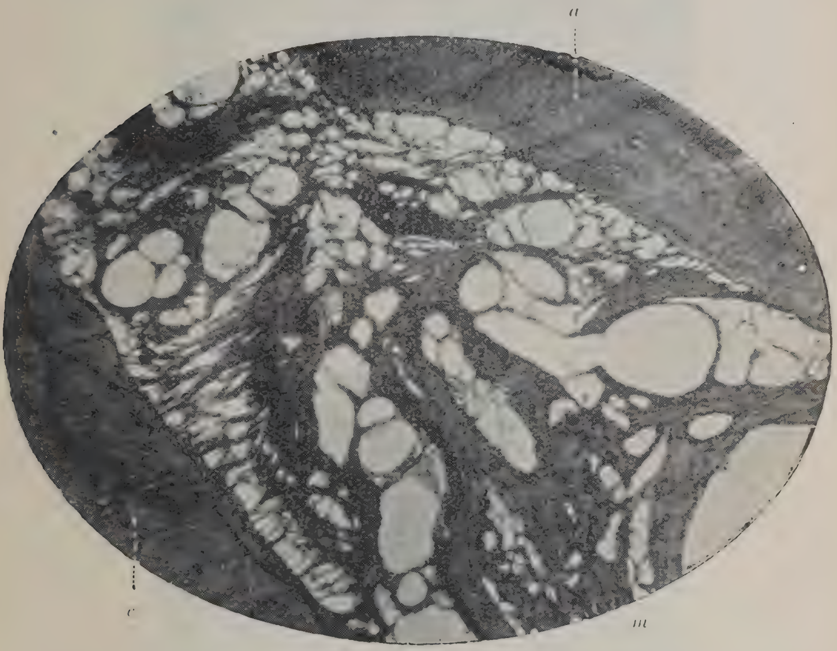

Fig. 647.[1]—(Hopewell-Smith). Transverse section of fibrosis of the periodontal membrane, cut *in situ*. × 260. (*c*) cement; (*a*) alveolar bone; (*m*) fibroid periodontal membrane showing absence of cells, blood-vessels, nerve fibres, &c.

(D) GRANULOMES

This is a convenient term to describe those masses of tissue often seen in connection with teeth which have been the seat of chronic periodontitis. Examples are shown in fig. 648. In some cases the mass is composed entirely of granulation tissue (fig. 649) while in others, in addition to the granulation tissue, epithelial cells or endothelial cells may be present. Figs. 650 and 651 show the general structures of granulomes.[2] In a few examples there is a peculiar development of mucous tissue.[1] The granulomes containing epithelium vary considerably in structure. In some there is a marked growth of epithelium, whilst, in others, granulation tissue prevails, which would seem to indicate that there is a kind of struggle for existence between the epithelial and the granulation tissue. The epithelium is not always easy to detect. In the two specimens

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[1] From *Dental Cosmos*.

[2] See an excellent paper by K. H. Thoma, *Dental Cosmos*, January, 1918. I am indebted to the author and the *Dental Cosmos* for permission to reproduce the figs. 650 and 651.

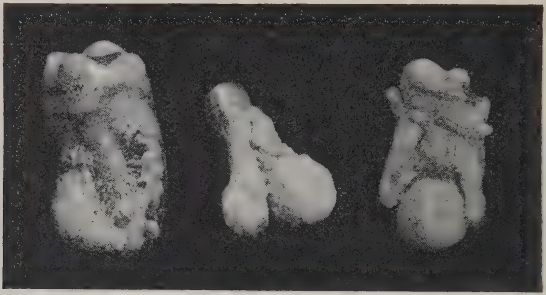
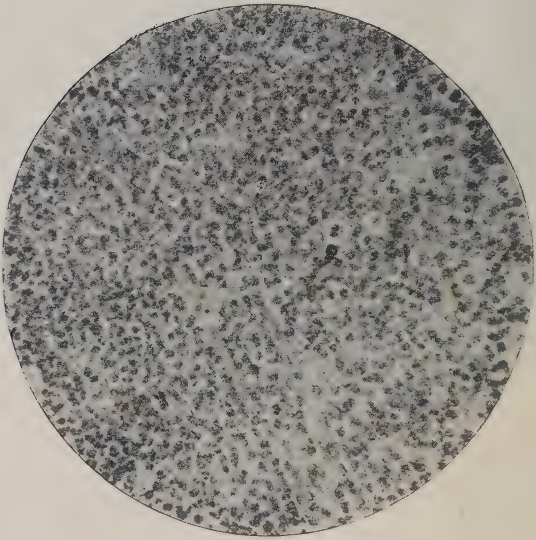


FIG. 648.



× 230.

FIG. 649.[2]—A granulome of the periodontal membrane.

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[1] See paper "On Granulomes and Tooth-root Cysts." Translated from the *Correspondenz-Blatt für Zahnärzte* (Ash's *Quarterly Circular*).

[2] From "The Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

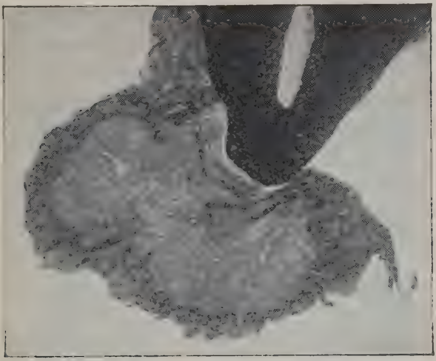

Fig. 650.—Photomicrograph of a granulome stained with Mallory's phosphotungstic acid hæmatoxylin method to bring out the fibrous part of the tissue. Note the strong fibrous capsule. The inner part of the granulome shows centres where necrosis has taken place. (Thoma.) (From the *Dental Cosmos.*)

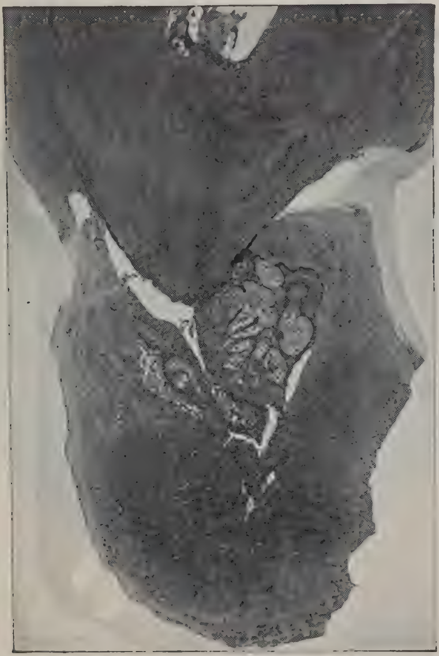

Fig. 651.—Photomicrograph of a dental granulome showing epithelium proliferating in the inflammatory tissue. Note that the epithelial network encloses inflammatory tissue. (Thoma.) (From the *Dental Cosmos.*)

described by Romer the granulation tissue had worked its way into the root canals, and only in that situation was he able to demonstrate epithelial remnants. The epithelial remnants found in these granulomes are probably derived from the "epithelial sheath of Hertwig," which is credited with determining the formation and shape of the dentine of the root. On the formation of the dentine,

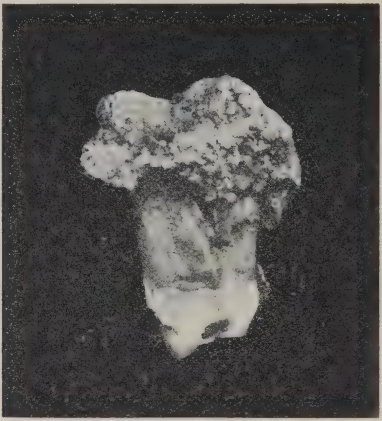

Fig. 652.[1]

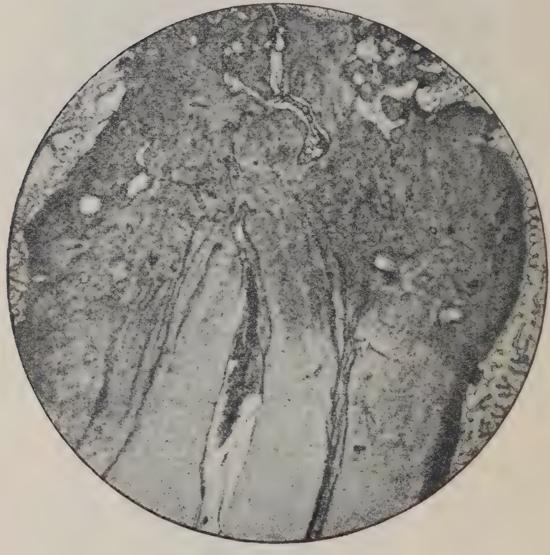

Fig. 653.[1]

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[1] Copied from *Trans. Odonto. Soc.*

the surrounding mesoblastic cells invade and partly destroy the sheath, and, applying themselves to the surface of the dentine, form the cement and periodontal membrane. Portions of the sheath remain at times undestroyed and these form the periodontal epithelial remnants.

The epithelial granulome is the first stage in the development of a dental cyst.

It is quite possible that some of the varieties of sarcoma met with in the jaws originate in the root membrane. In a case recorded by Oakley Coles[1] of a mandibular second molar which had been the seat of chronic periodontitis, the structure of the small growth removed with the teeth was identical in character with a round-celled sarcoma. Hopewell-Smith[2] has also described cases of a similar nature.

(E) ANCHYLOSIS OF THE TEETH TO THE JAWS

Anchylosis of the teeth to the jaws may occur, but it is rare. The pathological changes which produce this condition between the teeth and the alveolar process are similar to those occurring in joints in other parts of the body. An interesting case came under the notice of E. Lloyd-Williams. The patient was a man suffering from suppuration, and a maxillary molar and premolar were removed with large masses of bone attached to them. Examination of the specimens showed them to be examples of anchylosis of the teeth to the bone. The molar is shown in fig. 652, while a decalcified section of the premolar is seen in fig. 653. It will be noticed that the tooth and bone are intimately connected. An interesting case of anchylosis to the jaw of a retained deciduous molar in a man aged 40 is described by O. Amoedo.[3]

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[1] *Trans. Odonto. Soc.*, vol. xi, p. 115, "On a Tumour arising from the Root Membrane."

[2] "On Malignant Diseases of the Periodontal Membrane," *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 578.

[3] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 249.

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CHAPTER XVII

Chronic General Periodontitis commencing at the Gingival Margin — Synon.: Periodontal Disease; Pyorrhœa Alveolaris; Alveolar Osteitis; Interstitial Gingivitis

The Anatomy of the Periodontal Membrane—Morbid Anatomy—Clinical Appearances—Condition of the Teeth—Sequelæ—Pathology—Bacteriology—Etiology—Treatment

Chronic general periodontitis consists in a progressive destruction of the tooth socket, accompanied sometimes in the earlier and almost always in the later stages by a free discharge of pus from the gum margin. Descriptions of the disease will be found in the works of Ambrose Paré, Fauchard, Toire, John Hunter, and others. These authors, however, only described the disease in its advanced stages, the initial stages not having been recognized until recent years. This disease is widely distributed throughout the human race, and is also met with in animals under domestication, and wild animals, more especially those kept in captivity.

Various names have been given to the condition, e.g., Riggs' disease, pyorrhœa alveolaris, alveolar osteitis, &c. The disease, as far as our present knowledge guides us, would seem to start in the gingival tissues, and thence spread to and gradually involve the whole of the tooth attachments. The latter condition is the characteristic feature of the disease, and it would therefore seem appropriate to describe the lesion as a chronic general periodontitis.

(A) THE ANATOMY OF THE PARTS INVOLVED IN THE DISEASE

Before a description is given of the morbid anatomy of periodontal disease, it is necessary to consider certain aspects of the normal anatomy of the parts involved in the disease in order that the pathological changes may be more readily appreciated.

(1) The Osseous Tissues

As regards the mandible, fig. 654 shows that of a female, aged 22.

The alveolar process may be regarded as normal. The alveolar process and the teeth sockets are everywhere lined with a fairly dense layer of bone which appears in the radiograms, fig. 655, as a dark line. On the buccal aspects in the premolar and molar region the margin of the bone is close below the necks of the teeth, and, stretching across from one tooth to another in a straight line, forms the base of a definite triangular space between the approximal aspects of the teeth. In the incisor region the bone does not follow a straight line, but is continued upwards, so that the space between the incisors is considerably less than between the premolars and

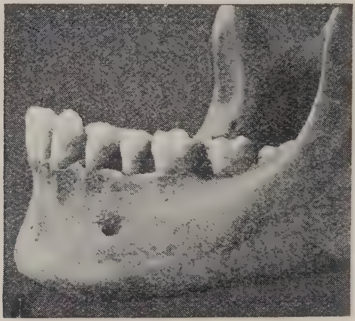

Fig. 654.—Mandible of female, aged 22, with an alveolar process which may be regarded as normal.

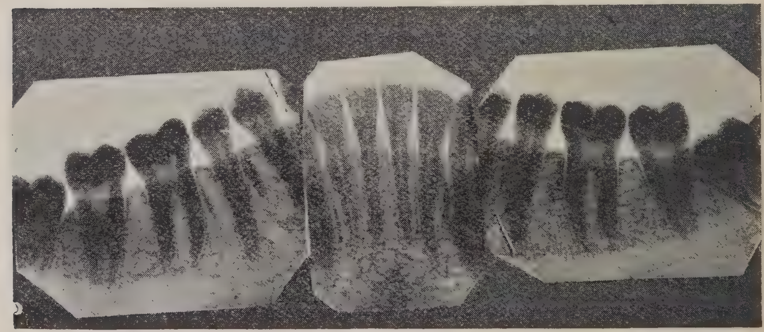

Fig. 655.—Radiograms showing the appearance of the bone in the mandible in fig. 654.

molars. The margin of the bone presents a regular outline, and the surface of the bone, which is smooth, is pierced here and there with nutrient canals. The appearance of the bone in radiograms is shown in fig. 655. Between the front teeth the bone has the appearance of a sharp spine, but it passes in a straight line between the back teeth. The outer aspect of the bone shows a dense layer, the inner part presenting a cancellous appearance. In the maxilla a similar condition obtains.[1] As age advances the alveolar process tends gradually to disappear.

(2) The Soft Tissues

In healthy mouths, the gum margin recedes as the alveolar process disappears and a layer of compact tissue is constantly present over the alveolar process. The muco-periosteum should be firm and pale pink in colour. It should blend with the periodontal membrane at the neck of the tooth, the junction being distinguish-

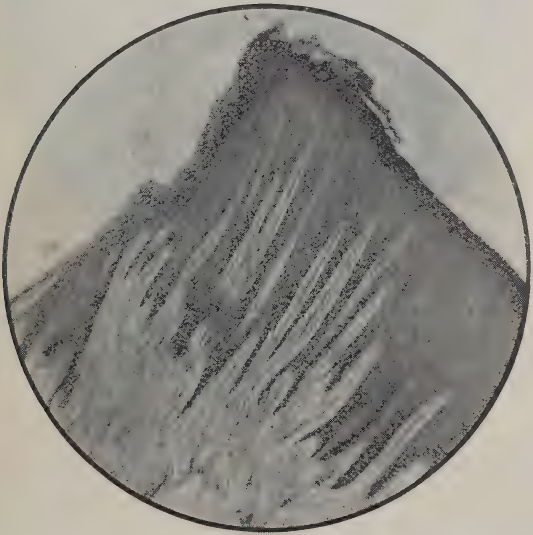

Fig. 656.—Gingival margin showing finger-like projections of connective tissue into the epithelium. (Box.)

From a photograph kindly lent by The Canadian Dental Research Foundation.

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[1] The radiogram of the incisors shows a slight break in the compact tissue towards the apex of the spine, but this is due to slight fracture (post mortem).

able by the greater density in the character of the fibrous tissue. This band of tissue has been termed by G. V. Black the *dental ligament*. The gingival margin of the muco-periosteum is not attached to the tooth on the general level of the gum, as the gum falls slightly before reaching the tooth and forms a slight depression around the tooth. This depression is generally termed the "gingival trough." The floor of the depression is at the neck of the tooth, and consequently with the eruption of the tooth the depth of the depression decreases.

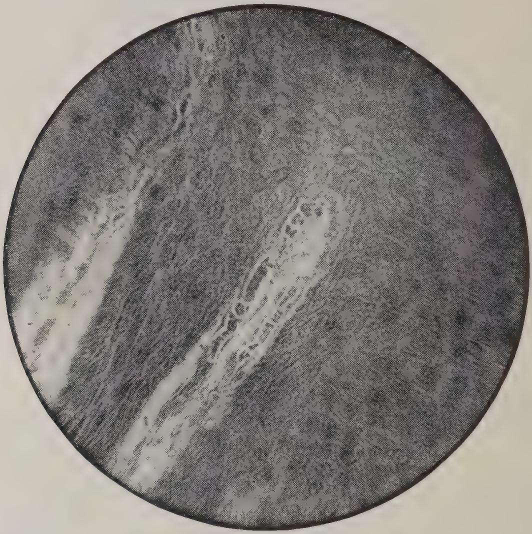

FIG. 657.—Section showing capillary loop at the extremity of a connective tissue papilla. (Box.)

From a photograph kindly lent by The Canadian Dental Research Foundation.

The minute anatomy of the gingival margins has been carefully described by H. K. Box.[1] The epithelium covering the margins is of the squamous type and rests on a basement membrane; it becomes thicker and stronger from the point opposite the crest of the alveolar process to the crest of the gum margin. "A characteristic of the marginal gingivæ is the invagination into the epithelium of finger-like papillæ of connective tissue" (fig. 656). The gingival margins have an excellent blood supply, the connective tissue projections containing an arteriole which passes to its extremity and terminates in a capillary loop which returns as a vein (fig. 657).

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[1] *Journ. Nat. Dent. Assoc.*, vol. viii, No. 8, p. 599.

The functions of the gingival margins and gingival trough have never been satisfactorily demonstrated, but it is possible that they are for the protection of the periodontal membrane. The free margin of the gum probably prevents direct injury of the membrane during mastication. With regard to the gingival trough, W. J. Penfold has shown that in the normal mouth the base of the trough is sterile. Mendel[1] observed that leucocytes are present in the gingival trough in healthy mouths, and this would seem to suggest

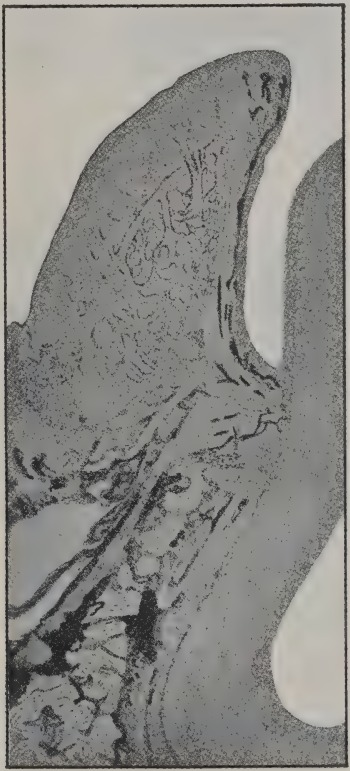

Fig. 658.—Unstained section, showing lymph capillaries of the tooth side of the gingival margin and their drainage through the dental ligament to the periodontal membrane. (Noyes and Dewey.)

From *Journ. American Med. Assoc.*

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[1] *Comptes rendus Soc. Biol.*, 1916, pp. 587 to 593.

that the leucocytes play the part of phagocytes in freeing the gingival trough from organisms and so indirectly protecting the periodontal membrane from infection.

The lymphatics of the gingival margins have been described by Noyes and Dewey.[1] Those from the external slopes of the gum margins pass along the periosteum of the bone to the wreath-like network of lymphatics at the reflection of the lip and the cheek; those from the inner aspect of the gum margins penetrate the dental ligament and pass direct towards the apex of the tooth; here they join the lymphatics from the pulp and then anastomose with the lymphatic network in the bone (fig. 658).

(B) MORBID ANATOMY

(1) The Alveolar Process

Clinical experience indicates that periodontal disease usually originates either in the molar region or around the incisors. When it originates around the back teeth, the initial lesion in the bone is a slight destruction of tissue in the centre of the interproximal spaces as shown in fig. 659, a specimen which has the appearance of being normal unless carefully scrutinized. The disappearance of the layer of dense tissue and the breach into the cancellous bone indicate that the destruction of the bone has already commenced (fig. 660). As the destruction of the bone proceeds the outer and inner plates of the alveolar process become involved, but the loss of tissue, as a rule, is greater between the teeth than on the buccal and palatal aspects. This stage is shown in fig. 661. It will be observed that:—

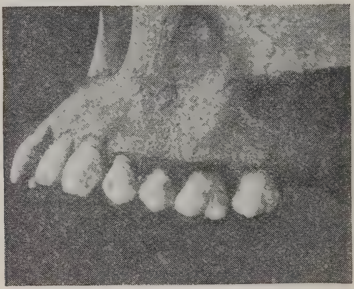

Fig. 659.

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[1] *Journ. American Med. Assoc.*, October 12, 1918, pp. 1179 to 1184.

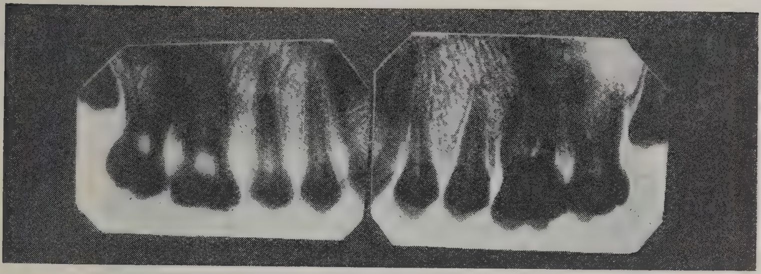

FIG. 660.—Radiograms of the specimen shown in fig. 659. Note the slight destruction of the bone in the centre of the interproximal spaces.

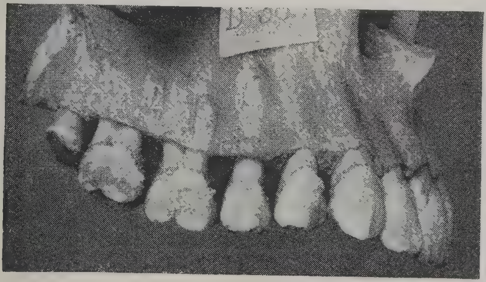

FIG. 661.—Maxilla in which the destruction of the bone has advanced beyond the stage shown in fig. 659.

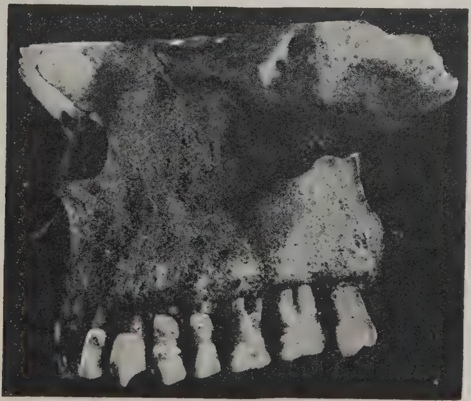

FIG. 662.—Maxilla showing considerable destruction of the alveolar process.

(*a*) The destruction of bone around the front teeth is considerably less than around the premolars and molars.

(*b*) The loss of tissue around the molars is greater than around the premolars.

A further stage of the disease is shown in fig. 662. The bone has so far disappeared as to expose about half of the roots of the incisors and two-thirds of the roots of the molars. Around the canine and premolars the bone destruction is less advanced.

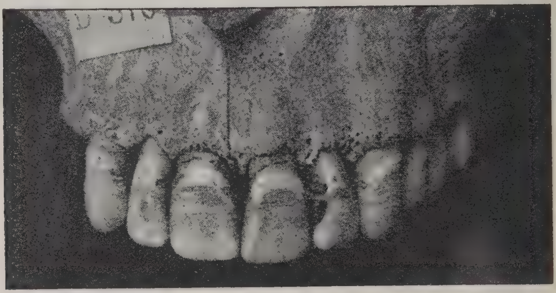

FIG. 663.—Specimen in which the disease probably commenced around the incisors.

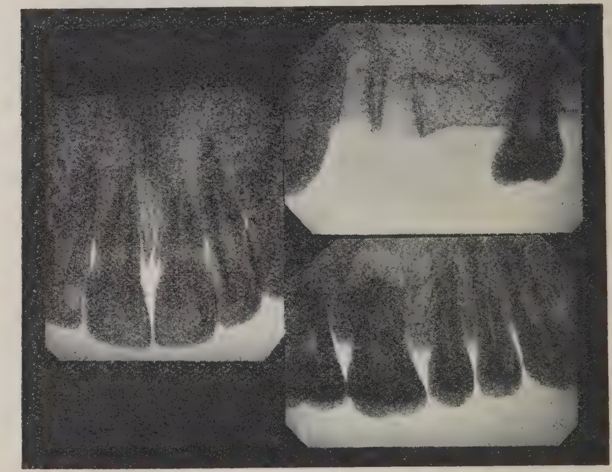

FIG. 664.—Radiograms of specimen shown in fig. 663. The extent of the bone lesion and the resistance of the tissues between the first incisors is clearly shown.

A specimen in which the disease probably commenced around the incisor teeth is shown in fig. 663. There is some loss of bone between the teeth, and the roots on the labial aspects are uncovered. The margin of the bone shows the pitted, irregular appearance characteristic of rarefying osteitis. It will be observed that there has been less destruction of bone between the first incisors than between the other front teeth. An examination of

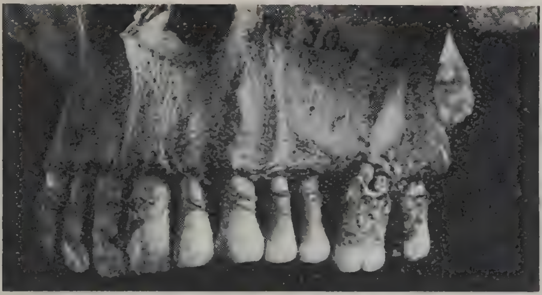

Fig. 665.—This specimen from a male, aged 30, shows the morbid anatomy of an advanced case of periodontal disease.

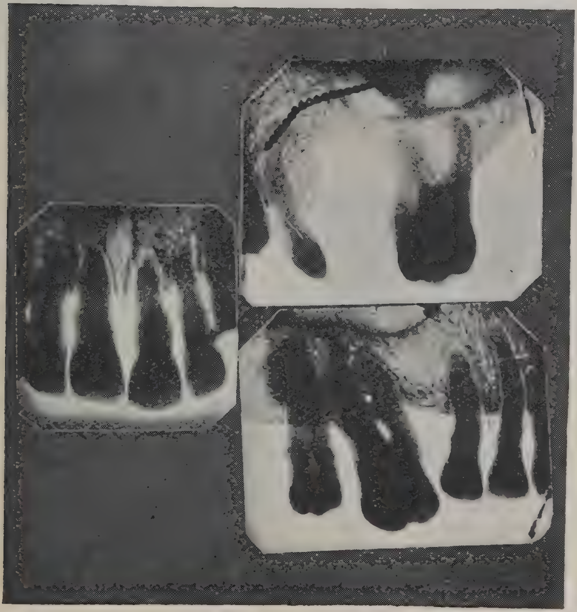

Fig. 666.—Radiograms of maxillæ shown in fig. 665.

the specimen shows that around the incisors the destruction of bone is more advanced than around the molar teeth. The radiograms, fig. 664, bring out clearly the extent of the bone lesion and also the resistance of the tissues between the first incisors.

The specimen shown in fig. 665, from a male, aged 30, is an excellent example of the morbid anatomy of an advanced case. The bone around the incisors has almost disappeared, and the molar teeth are uncovered nearly to their apices. Around the teeth are cup-shaped spaces which are due to the fact that the bone bordering the tooth disappears first. The appearance of the bone shows that there has been a marked rarefying osteitis. Nodular deposits of calculus are present on the teeth, and it will be observed that these are, in the case of the incisors, canines, and premolars, well away from the margin of the bone. The radiograms of this specimen are shown in fig. 666. The cup-shaped absorption of the socket is clearly shown in the right first molar of the specimen illustrated in fig. 667. Around the second molar the destruction of the bone

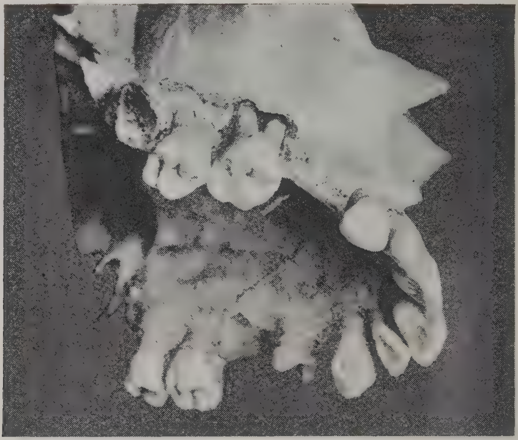

Fig. 667.—Maxilla showing cup-shaped absorption of the bone around the right first molar.

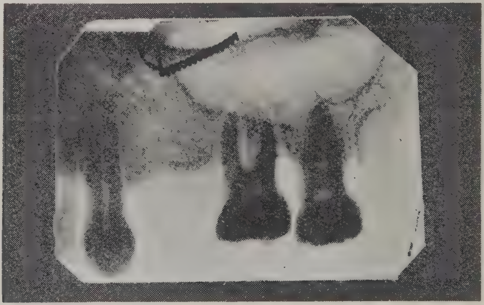

Fig. 668.—Radiogram of the first and second molars in fig. 667, showing the different degrees of bone destruction around these teeth.

has been of a more chronic type, the cup-shaped absorption being absent. The radiogram of these two teeth (fig. 668) shows a very distinct difference in their appearance. Around the roots of the first molar there is a definite clear area, and the dense layer which marks the outline of the normal socket is absent. The bone around the tooth shows definite signs of rarefying osteitis. The bone bordering the roots of the second molar still retains the dense appearance, and this indicates that the rarefying process has not spread deeply into the bone around the tooth.

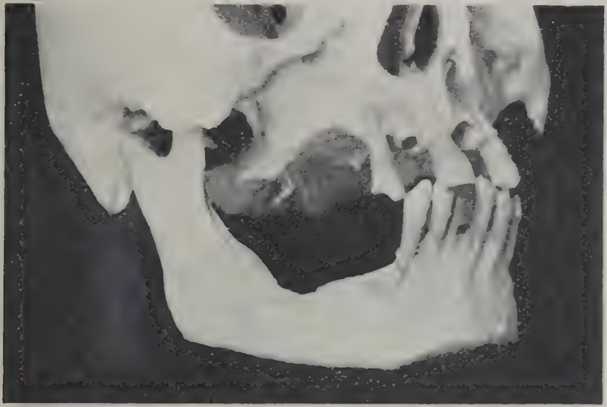

FIG. 669.—Final stage of the disease. The teeth have fallen out owing to the extensive destruction of the surrounding bone.

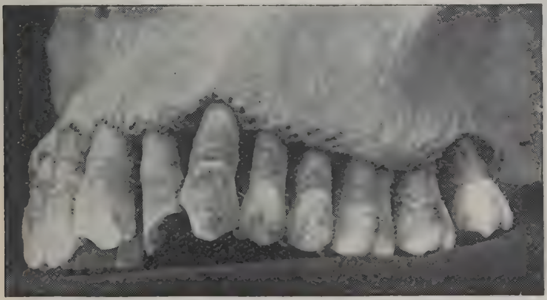

FIG. 670.—A specimen in which the bone shows marked reaction. Note the thickened margin of the alveolar process.

In the final stage of the disease the teeth fall out owing to the extent of bone destruction. The specimen shown in fig. 669 is an excellent example of this condition. The premolars and molars have fallen out and the alveolar process has entirely disappeared.

The condition of the mandibular canine shows how the final loss of the tooth is brought about. In the living subject this advanced stage of the disease is denoted by the absence of "ridges."

In specimens showing marked attrition of the teeth the outer aspect of the alveolar process is often thickened and the rarefaction of the bone is limited to the alveolar margins. A case of this type is shown in fig. 670. The radiograms (fig. 671) show that the rarefying process is almost entirely limited to the surface and has not spread deeply into the sockets. Compare the radiographic appearance of the bone around the incisors in this specimen and in the specimen shown in fig. 665. The marked attrition of the teeth indicates that the function of mastication has been efficiently performed, and the bone around the teeth, having therefore been kept well nourished with a plentiful flow of blood, was in a favourable condition to react to injury.

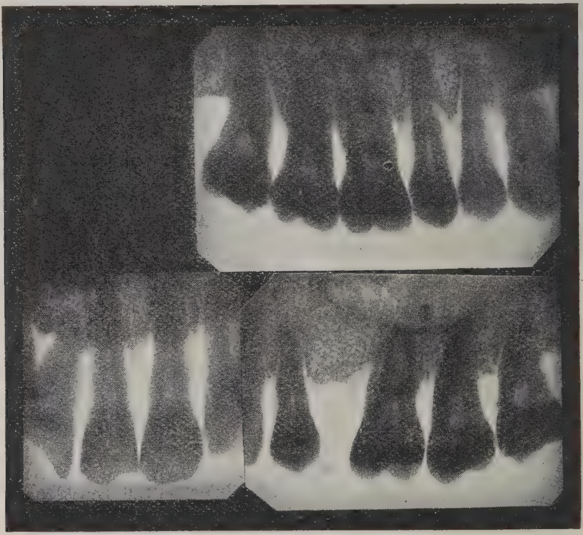

FIG. 671.—These radiograms of fig. 670 show that the rarefaction of bone is to a great extent limited to the surface.

A specimen in which there is greater thickening of the bone is shown in fig. 672. The position of the calculus in relation to the margin of the bone is evidence that well-defined pockets existed around the teeth. The surface of the bone around the teeth shows signs of a rarefying osteitis, but there is no cup-like absorption of the bone. The thickened bone beyond the surface indicates a "sclerosing" inflammation. The arch is well formed and the attrition of the teeth on the masticating surface points to good functional activity.

An example of the formation of nodular masses of bone is shown in fig. 673.

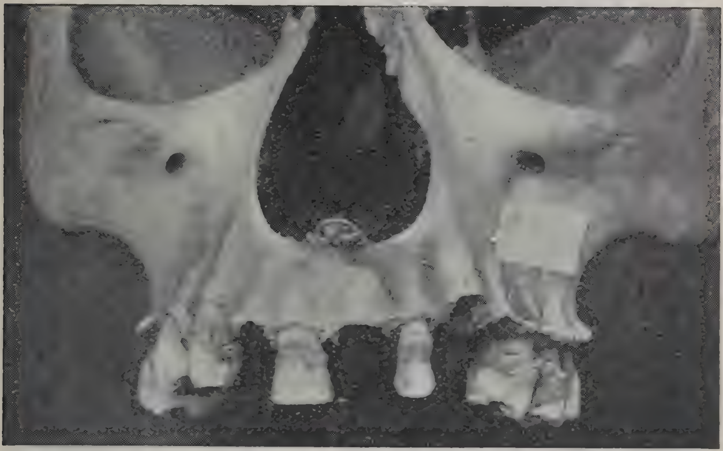

Fig 672.—A specimen from a very chronic case showing considerable thickening of the margin of the bone.

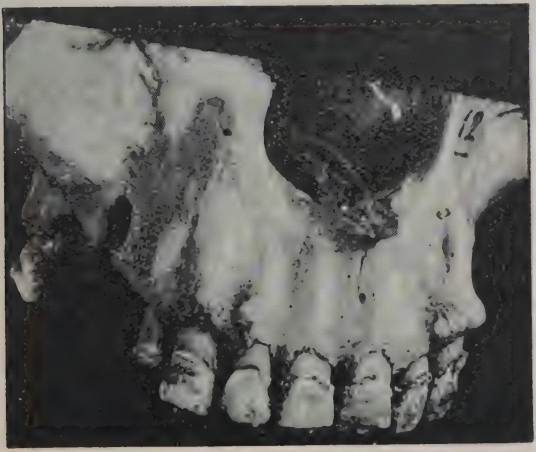

Fig. 673.—A specimen showing the formation of nodular masses on the outside of the alveolar process.

In practice a type of case is met with in which the bone destruction on the labial and palatal aspects of the teeth is much more advanced than on the approximal aspect. In many of these cases the gum margin is very little above the neck of the tooth, and a probe inserted between the gum and the tooth will pass almost to the end of the root. This condition is generally associated with the anterior teeth, and not infrequently with patients whose teeth are unduly prominent. A specimen illustrating the morbid anatomy of this type of case is shown in fig. 674. The bone on the labial aspects of the right canine and first incisor has completely disappeared; the left first incisor and canine are only covered by bone in the neighbourhood of the apices. Note the deposit of calculus around the necks of the teeth and the freedom from calculus of the remaining exposed portions of the roots. On examining the position of the teeth in relation to the bone, it will be seen that the arch is decidedly narrow and that the general direction of the teeth is too vertical.

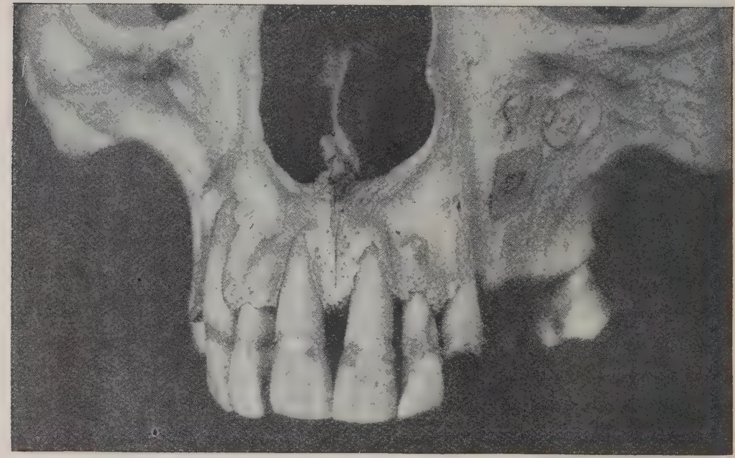

Fig. 674.—In this specimen the bone destruction is most marked on the anterior aspects of the teeth.

A point worthy of attention is that the disease spreads in the maxilla more actively and extensively than in the mandible; especially is this the case in the region of the molars. The more limited area of bone destruction in the mandible is due to the nature of the osseous tissues, the bone in the maxilla being of a much more cancellous character than in the mandible.

A mandible showing extensive destruction of the bone in the region of the molars is shown in fig. 675, and the radiograms of the specimen in fig. 676.

The series of specimens just described indicates that the bone lesion is a progressive rarefying osteitis which commences at the margin of the tooth socket and eventually destroys the bone until the tooth is shed owing to the loss of its attachments.

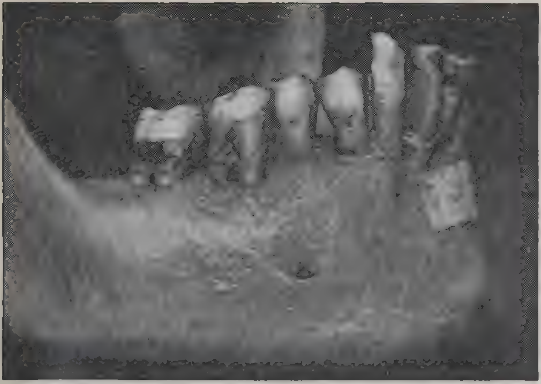

FIG. 675.—Mandible from an advanced case of periodontal disease in the region of the mandibular molars.

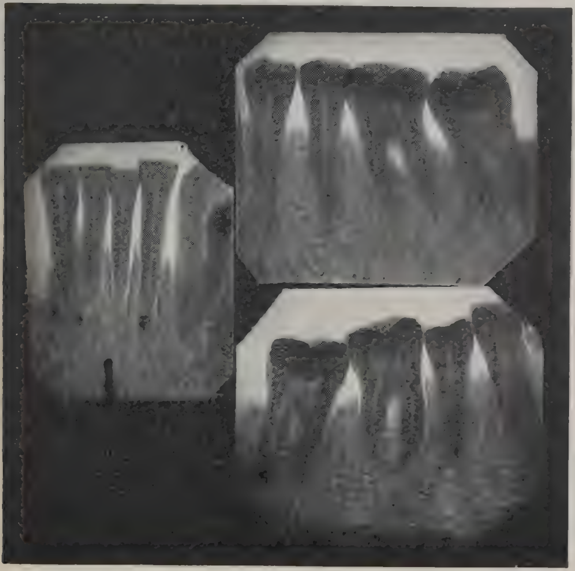

FIG. 676.—Radiograms of the specimen shown in fig. 675.

(2) The Teeth

Teeth taken from cases of periodontal disease exhibit definite changes. The hard tissues may show absorption and the periodontal membrane may be thickened—indications of a chronic inflammatory process. When the hard tissues around the apex of a tooth are being absorbed the presence of periodontitis is indicated, and periodontitis necessarily implies pathological changes in the adjacent bony tissue. The pulps of teeth affected by periodontal disease are invariably infected and show a tendency to fibrosis. Turner and Drew[1] have shown that the cement may be infected from the periodontal membrane. The illustration, fig. 677, taken from their paper, shows infection by a streptococcus.

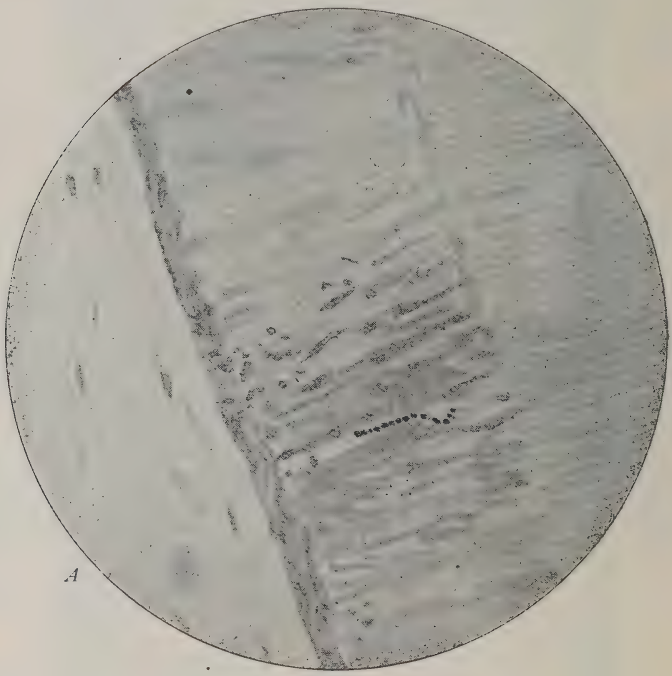

Fig. 677.[2]—Infection of the cement by a streptococcus. From a paper by Turner and Drew.

The degree of rarefying osteitis may be gauged by the rapidity of tooth absorption, and the liability to direct infection of the tissues increases in proportion to the amount of rarefying osteitis. The condition of the teeth in fig. 678 indicates that there was marked rarefying osteitis and probably direct absorption of toxins, &c., into the blood-stream. Radiograms of the alveolar process of the patient are shown in figs. 679 to 681.

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[1] *Proc. Roy. Soc. Med.* (Odonto. Sec.), vol. xii, pp. 104 to 118.

[2] *Proc. Roy. Soc. Med.* (Odonto. Sec.).

Large masses of adventitious tissue are frequently found in the cleft between the roots of the molar teeth, indicating extensive loss of osseous tissue at those points. The condition of the teeth in cases exhibiting deep pockets and profuse suppuration is well shown in the specimens illustrated in fig. 682.

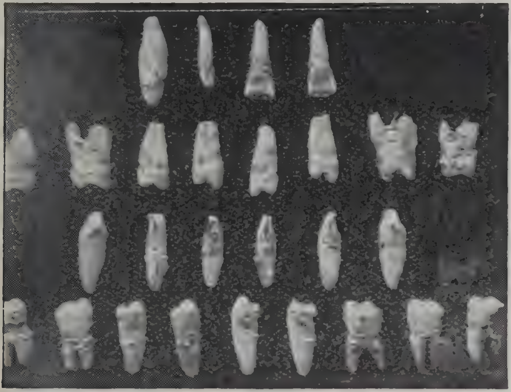

Fig. 678.

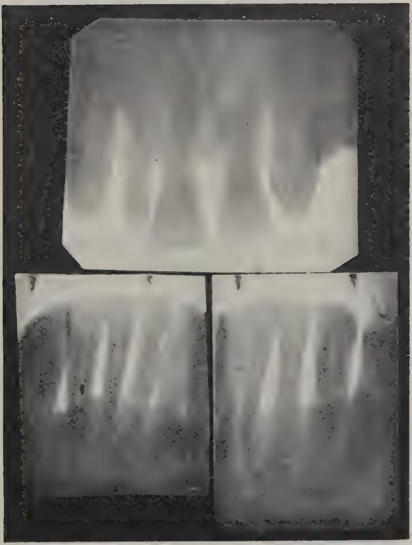

Fig. 679.

T. B. Hartzell[1] considers that the lymphatic drainage of the

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[1] *Medical World*, December 4, 1913, p. 688.

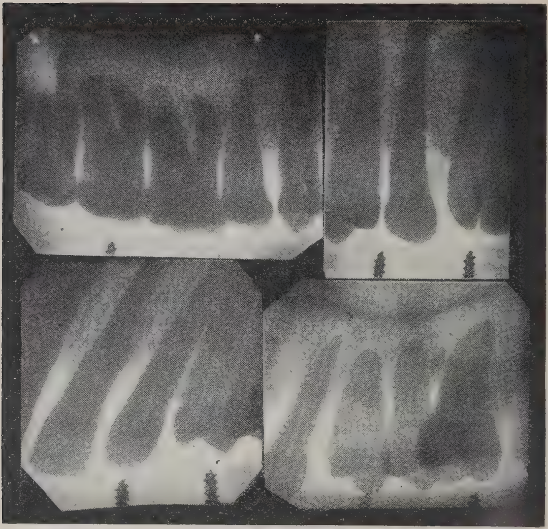

FIG. 680.

tissues contiguous to the teeth is the most perfect in the body, and he states that the very method of attachment of the tooth in its socket increases the danger of general infection. "The elastic nature of the periodontal membrane makes it possible for the teeth to bear the shock of mastication but the same elasticity favours the

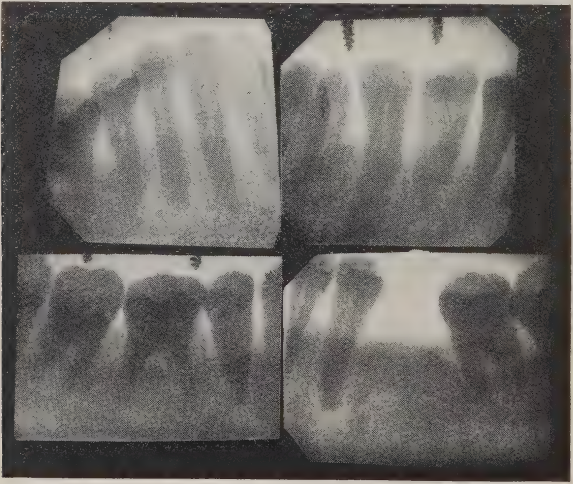

FIG. 681.

transmission of infection. If there is infectious material around the tooth, the strain of mastication forces the tooth downwards so that the root acts as a plunger, injecting the septic matter into the surrounding tissue."

In periodontal disease the area from which absorption can take place is often extensive.

It has been estimated[1] that if all the teeth are affected by advanced periodontal disease, the surface area absorbing poison is just over twenty square inches. Such an extreme condition is seldom seen, but it is not uncommon for a third of the surface area of the teeth to be involved in the disease. Diagrams showing the surface area involved in connection with different teeth are shown in figs. 683 and 684. In many cases of periodontal disease there is infection of the bone far beyond the immediate vicinity of the roots of the teeth, so that a cubical area rather than a superficial area is infected.

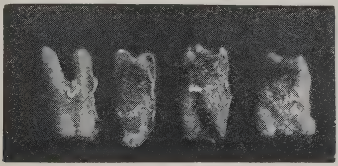

Fig. 682.

In cases where the disease has been extremely chronic the teeth become very brittle. The brittleness is probably due to increased calcification of the soft parts of the dentine and cement, and the process is as follows: The toxins injure the tooth tissues, which, like other tissues of the body, react, the reaction taking the form of an increased calcification of the soft contents of the dentinal tubes and cemental lacunæ, thus rendering the tooth more brittle. On being held to the light such teeth appear more translucent than normal teeth, especially about the apices, and if the teeth are immersed for six or eight weeks in borax carmine it will be found that the translucent area does not stain to the same extent as the other parts of the teeth, which indicates that the soft tissue normally present has undergone calcification.

Sections of teeth from three cases of periodontal disease are shown in fig. 685.

In **animals** that have been the subjects of this disease exactly similar changes are to be found in the bones, but the teeth show greater deposits of calculus owing to the absence of the system of artificial cleaning adopted by human beings, and specimens often show the spaces between the teeth choked up with food débris.

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[1] D. A. Crow, "Pyorrhœa Alveolaris."

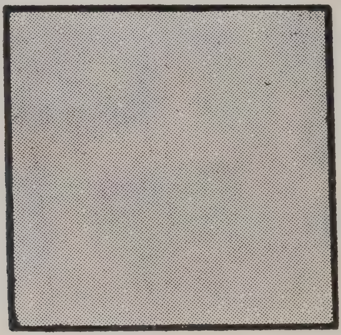
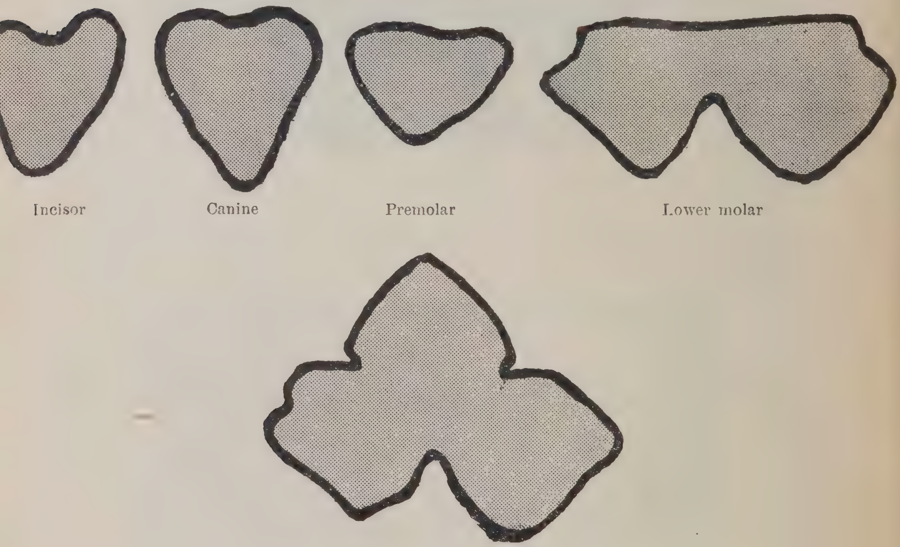


Fig. 683.[1]—Exact surface area (3 square inches) if the four mandibular incisors are affected by periodontal disease. (Crow.)



Incisor Canine Premolar Lower molar

Three-rooted upper molar

Fig. 684.[1]—Exact surface area of average tooth from the gum margins to the apices. (Crow.)

The following specimens show the different stages of the disease in animals:—

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[1] From "Pyorrhœa Alveolaris," D. A. Crow.

An early stage in seen in fig. 686, a Bennett's wallaby (*Macropus bennetti*). In the maxilla the septa between the anterior teeth have been partly destroyed and in the region of the first molars the bone shows signs of rarefying osteitis. A more advanced stage is shown in the skull of a brush-tailed kangaroo (*Petrogale penicillata*), fig. 687. Here the disease is more widely distributed.

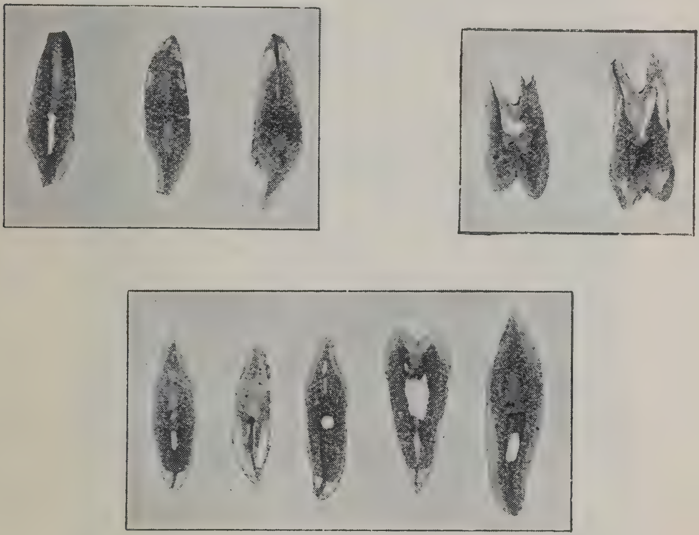


Fig. 685.

Teeth from cases of periodontal disease showing translucent areas.

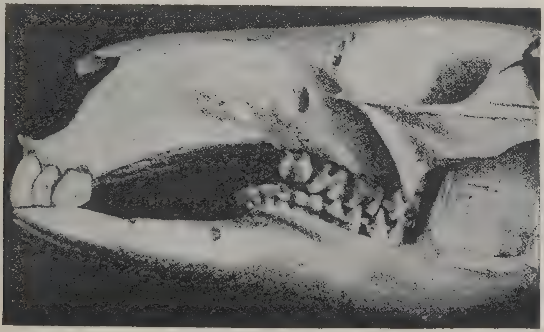


Fig. 686.—*Macropus bennetti* (Bennett's wallaby) showing an early stage of periodontal disease. The loss of bone is more marked in the maxilla than in the mandible.

The specimen, fig. 688, illustrates a further stage. The bone has been extensively destroyed in the neighbourhood of the maxillary right molars; the bone shows signs of rarefying osteitis. The disease is more advanced in the maxilla than in the mandible. In the left half of the skull and mandible, fig. 689, the disease has caused the loss of all the cheek teeth with the exception of one molar in the maxilla and one molar in the mandible.

In carnivora a similar graditional series can be traced, the disease tending to spread more rapidly and extensively in the maxilla than in the mandible owing to the less dense character of the former bone (see fig. 690).

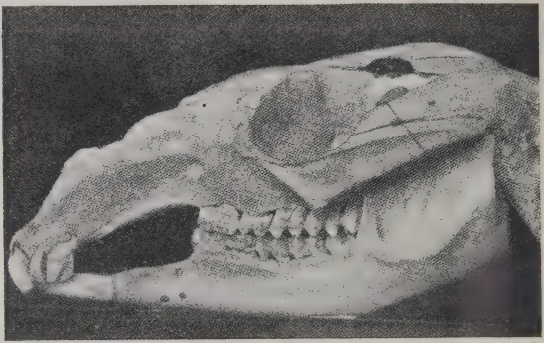


Fig. 687.—*Petrogale penicillata* (Brush-tailed kangaroo). In this specimen the disease is more advanced than in the specimen fig. 686.

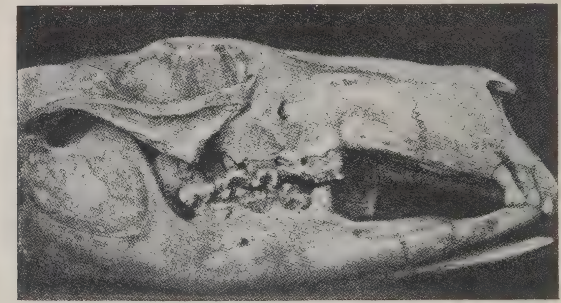


Fig. 688.—Macropus—species unnamed. The disease is well advanced and is more marked in the maxilla than in the mandible.

In herbivora the infection does not tend to spread far beyond the area affected. The localization of the infection is particularly noticeable in the maxillæ of herbivora, and this is probably due to the fact that in the herbivora this bone is denser in character than

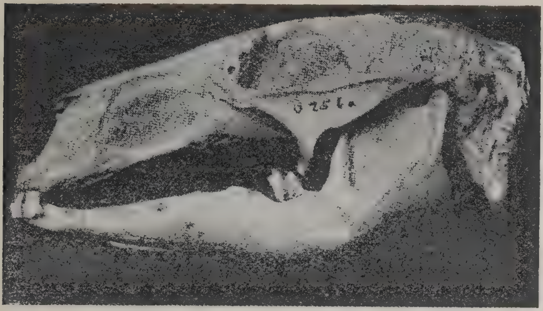


FIG. 689.—Macropus—species unnamed. The majority of the teeth have been lost from periodontal disease.

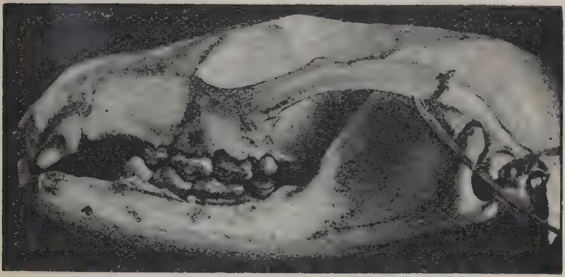


FIG. 690.—*Paradoxurus larvatus* (Chinese palm civet). The destruction of the bone is more marked in the maxilla than in the mandible.

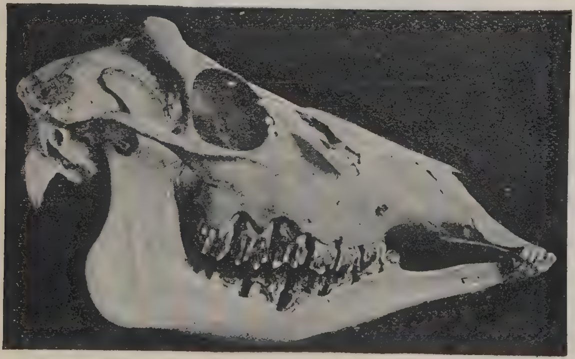
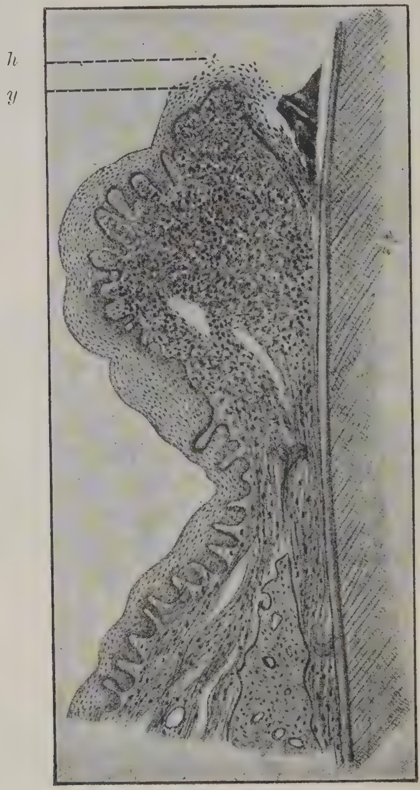


FIG. 691.—*Cervus eldii* (Panolia Deer). The destruction of the bone is most marked in the region of the first molar.

in the carnivora. This point is shown in the skull and mandible of a Panolia deer (fig. 691).

The conclusions to be drawn from an examination of skulls showing the disease are:—

(*a*) That the bone lesion is a progressive rarefying osteitis commencing at the margin of the alveolar process, and (*b*) that the rate of destruction is in proportion to the density of the bone.



× 80.

Fig. 692.[1]—In this section the infiltration of the gum margin with leucocytes is seen. At (*h*) the epithelium is destroyed; (*y*) epithelium commencing to disintegrate. The bone is normal.

Microscopical investigation of the tissues in the various stages of this disease in man were carried out by Znamensky.[2] This author records the result of his examination of sections obtained from a female aged 39 who had suffered from pyorrhœa alveolaris. The patient died of acute anæmia, the result of hæmorrhage after parturition. The decalcification of the preparations was accomplished by means of a 3·5 per cent. solution of trichloracetic acid. Some of the sections were stained with eosin and hæmatoxylin and others in Loeffler's blue, and the sections were afterwards mounted in Canada balsam. The series of sections showed the progressive development of the pathological process. In all the sections a deposit of calculus was present under the gum margin. The sections showed that the pathological process was of an inflammatory character, originating in the gum, and then successively involving the periodontal membrane and the adjacent bone and finally causing their destruction. The destructive process in the bone near the margin of the socket consisted in the decalcification of the bone and its transformation first into an osteoid tissue and afterwards into a fibrous intervening tissue which subsequently became infiltrated with leucocytes. In the part of the socket where

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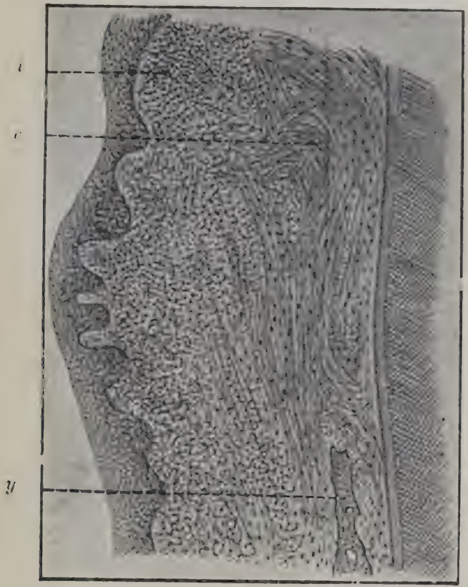
[1] From *Journ. Brit. Dent. Assoc.*

[2] *Journ. Brit. Dent. Assoc.*, vol. xxiii, p. 585.



× 80.

FIG. 693.[1]—This section shows that the inflammatory process proceeds from the periphery, namely, from gum towards the bone. (*i*) gum infiltrated with leucocytes; (*c*) normal gum; (*y*) normal bone.

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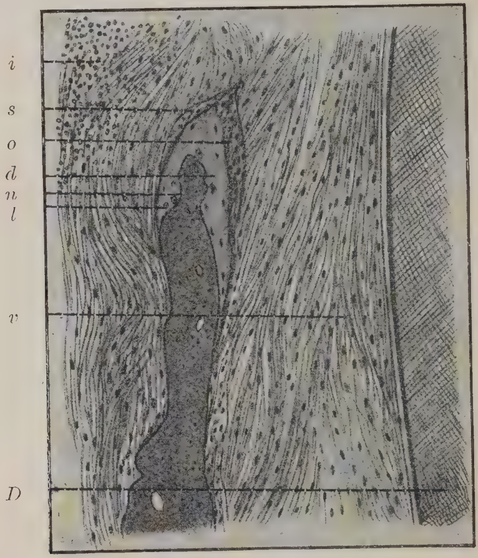
[1] *Journ. Brit. Dent. Assoc.*

the bone-marrow was present lacunar absorption of the bone was seen. The whole process was in the nature of a rarefying inflammation (see figs. 692 to 697).

E. S. Talbot[1] has examined the patho-histology of the disease in a series of dogs and has shown that the earliest manifestation is in the gingival margin, and that with the progress of the disease both the periodontal membrane and the bone become involved. The absorption of the bone is at times rapid and takes place by (*a*) lacunar absorption; (*b*) the formation of perforating canals; and (*c*) halisteresis (disappearance after prior absorption of lime salts).



× 180.

FIG. 694.[2]—In this section the implication of the bone in the disease is shown. (*i*) infiltration approaching from the gum towards the bone; (*s*) bone transformed into fibrous intervening tissue; (*o*) osteoid tissue; (*d*) bone partially decalcified; (*n*) bone corpuscles; (*l*) line dividing the healthy from the unhealthy bone; (*v*) periodontal membrane; (*D*) dentine.

The main features of the condition of the bone are well shown in fig. 697—a section taken from the human subject.[3]

The view expounded in the foregoing pages, viz., that the disease

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[1] "Interstitial Gingivitis."

[2] From *Journ. Brit. Dent. Assoc.*

[3] An interesting paper by H. K. Box, entitled "The Evolution of the Pyorrhœa Pocket," was published in the *Journ. Nat. Dent. Assoc.*, August, 1921.

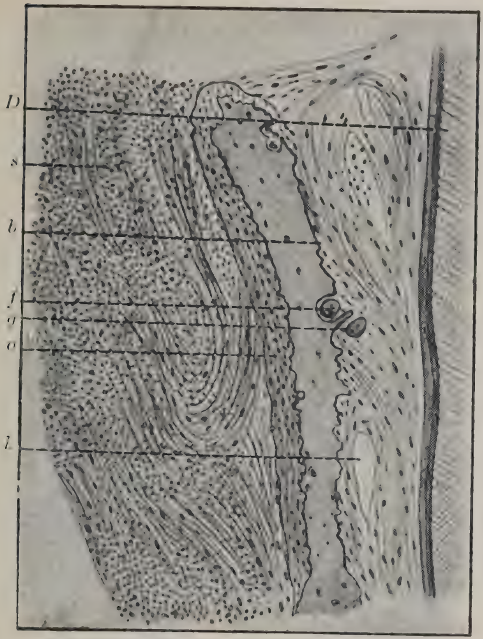


FIG. 695.—*o*, Outside of the tooth socket becoming connected with osteoid tissue; *b*, inside of the tooth socket showing Howship's lacunæ; *g*, osteoclasts; *f*, the so-called lacunar absorption of the bone is proceeding; the blood-vessels of the periosteum, *k*, are dilated, but the periosteum is but little infiltrated, the gum, on the contrary, showing considerable infiltration; *s*, reaching the bone of the socket; *D*, dentine. Magnified 180 times.

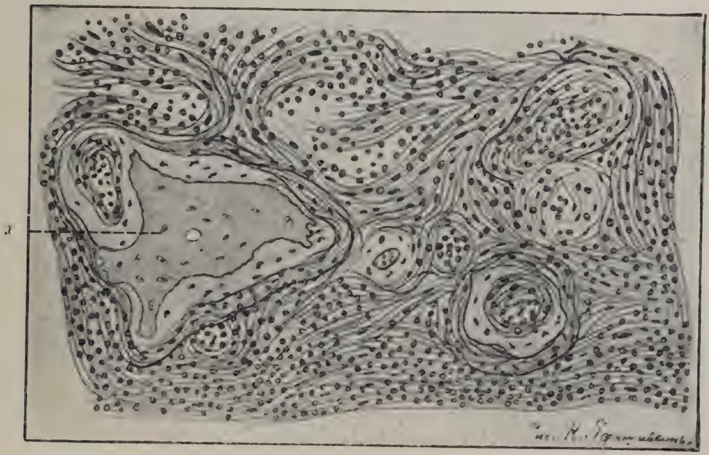
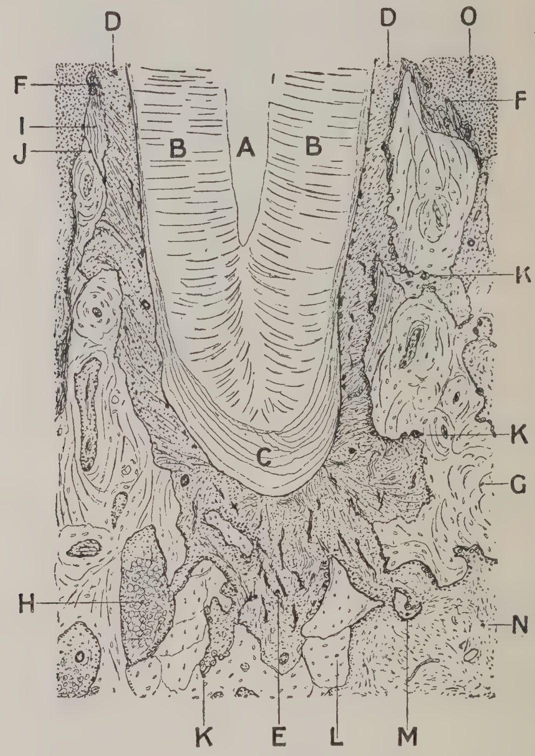


FIG. 696.—This section shows the concluding stage of the development of the disease in the marrow part of the bone; bony laminæ are absorbed and transformed into fibrous connective tissues very strongly impregnated with inflammatory infiltration. There is a sequestrum (*x*) to be seen which is beginning to be absorbed from the periphery. Magnified 360 times.

starts at the gingival margin and gradually involves the tooth attachments is not accepted by all writers. Gottlieb and Fleischmann[1] hold that atrophy of the bone is the primary causal factor in the etiology of the disease. They maintain that the sections shown in their paper afford evidence of destruction of the bone by autolysis before the small-celled infiltration of the gingival margin. Their



(From a drawing by A. Hopewell-Smith.)

Fig. 697.[2]—(a) Pulp cavity; (b) dentine on tooth; (c) hyperplasic cement around apex of root; (d) periodontal membrane, greatly thickened—hyperplasic; (e) indifferent tissue at apical region greatly increased in amount; (f) free edge of bone of socket becoming converted into fibrous intervening tissue; (g) bone of socket presenting earliest signs of osteoporosis; (h) large osteoporotic space in bone of jaw filled with bone-marrow; (i) bone of socket partially decalcified and converted into osteoid tissue; (j) junction of living with decalcified bone; (k) osteoclasts producing lacunar absorption; (l) bone of jaw only slightly altered by disease; (m) sequestrum undergoing peripheral absorption; (n) soft, cancellous tissue slightly changed from normal; (o) inflammation of gum at neck of tooth.

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[1] *Dental Cosmos,* vol. lxiii, p. 215.

[2] From *Lancet.*

sections, however, show that in the earliest stage the epithelium on the inner side of the gingival margin is thickened and that the epithelium pushes its way downwards between the cement and the attachment of the periodontal membrane; they also figure a small-celled infiltration in the sub-epithelial tissue which they regard as normal. But the fact that this small-celled infiltration is beneath the thickened epithelium is strongly suggestive of pathological changes—it is indeed the reaction of the mesoblastic tissue to the invading epithelium.

(C) CLINICAL APPEARANCES

In a young adult whose mouth is in a normal condition, the gums fit closely around the necks of the teeth and the spaces between the teeth are filled with tags of gum. In the earliest stage of periodontal disease these tags of gum become slightly congested, and, if a probe is passed into the inter-proximal spaces, it will be found that the gum has been partially destroyed. The congestion gradually extends to the whole of the margins of the gums, which then bleed readily. Next, the tags of gum between the teeth gradually disappear and the normal festoons are obliterated. At this stage an examination of the teeth will usually disclose the presence of particles of food and other débris in the approximal spaces and small nodules of calculus on the teeth. Lastly, the inflammatory process involves the bone which, together with the periodontal membrane, is slowly destroyed. The gums recede, but the recession does not ordinarily keep pace with the destruction of the alveolar process, and the result is that around the teeth deep pockets are formed in which pus and other morbid material accumulate and aggravate the condition. The mucous membrane is now deeply congested, the free margins of the gums are swollen and bleed at the slightest touch. The roots of the teeth are more or less exposed and are covered with a layer of hard greenish-brown calculus; there is a fœtid discharge and the breath has a repulsive odour which is due to indol-forming organisms. A sickly, sour odour of the breath is noticeable when yeasts and bacteria causing carbohydrate fermentation are present. The teeth are freely movable and may become so loose that they can easily be removed. If the disease is left untreated the teeth are lost one by one, and with the loss of the teeth the inflammatory process clears up.

The disease, especially in advanced cases, is usually associated with congestion of the tonsils and of the mucous membrane of the mouth and pharynx, and it is often accompanied by superficial glossitis. The patient experiences an unpleasant taste in the morning. There is frequently recurring hæmorrhage from the gums, which is swallowed during the day, but occasionally escapes from the mouth at night and stains the pillow. The last symptom deserves special attention, as there is some danger that it may be mistaken for hæmorrhage from the lungs.

The **clinical appearances of the disease,** which **vary considerably,** are determined by the general condition of the patient, the resistance of the tissues, and the hygiene of the mouth. At one period the condition may be acute, with a free flow of pus from the teeth sockets and a rapid destruction of the tissue. This state may be evanescent and may be followed by a period during which the inflammation is more or less quiescent. In some cases the teeth are comparatively free from calcareous deposits; in others they are completely coated. The disease may be more active around the anterior than around the posterior teeth, or vice versa. Again, the destruction of tissue may be more active in one region of the mouth than in another, e.g., the destructive process is often more advanced on the palatal than on the labial aspects of the incisors and canines.

In severe cases the disease may spread in the maxilla to the maxillary sinus, or in the mandible to the body of the bone.

"The buccal mucous membrane in advanced cases shows a number of small white stellate points, somewhat hard and shotty, lying underneath the mucous membrane, and corresponding in position to the site of the disease of the gum margin. From these glands bacteria of various species, generally bacilli, may be obtained." (Goadby.)

In some cases, where care is taken by the patient to keep the mouth clean, the gums are not sufficiently abnormal in colour to attract attention and the looseness of the teeth is the only indication of the presence of the disease. In such cases the probe will disclose deep pockets and pressure on the gum will cause a discharge from the tooth sockets. In a few cases the disease is slow in its progress, and the surrounding bone actively reacts to the injuries caused by the toxic products in the sockets. This is well seen in the case shown in fig. 698.

In certain cases there seems to be a tendency for granulation tissue to form, causing the condition to simulate sarcoma. In one case under observation, associated with myxœdema, the gums were friable and presented a translucent appearance.

The disease may often be well advanced without the patient having become conscious that anything is wrong, the only symptom being a tendency for the gums to bleed readily, and this is often unheeded by the patient. With the formation of spaces between the posterior teeth, neuralgia may arise from septic infection. In the later stages there is often persistent neuralgia owing to the main trunks of the nerves being involved in the diseased process. Where pus formation is active the patient will often complain of a general itching of the gums.

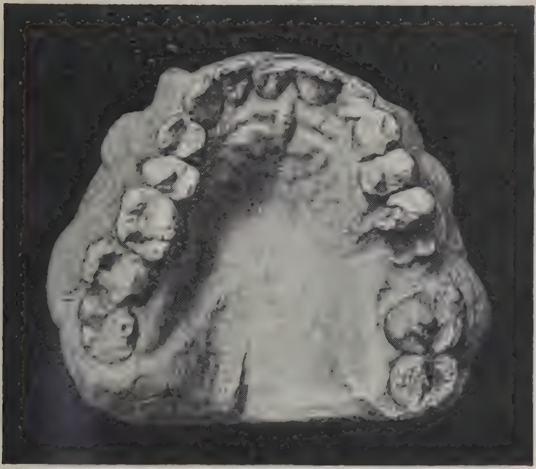

FIG. 698.—From a case under the care of J. G. Turner. Compare with fig. 673.

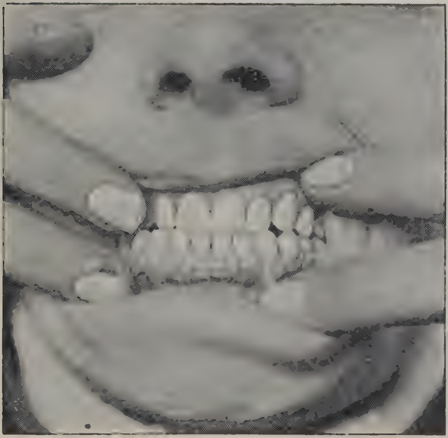

FIG. 699.

Whether the disease can be transmitted from one individual to another is an open question, but the balance of evidence is rather against it.

Clinical appearances alone are not altogether satisfactory guides as to the extent of the disease, and it is only by the aid of radiograms that the amount of the bone destruction can be estimated with any degree of accuracy. The following cases will serve to demonstrate the amount of bone destruction in relation to the clinical appearances.

The case shown in fig. 699 depicts an early stage of the disease.

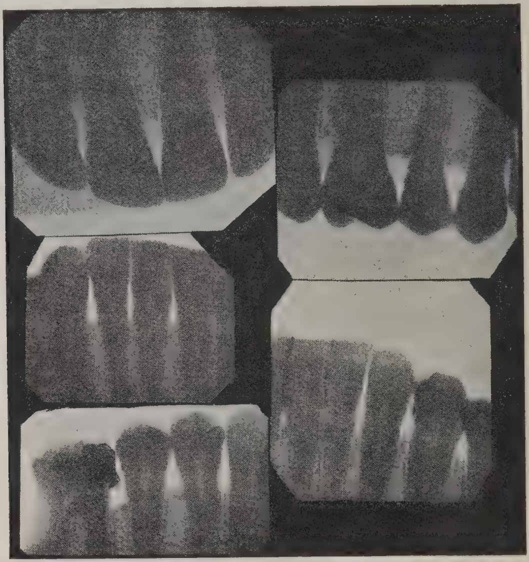

FIG. 700.—Radiograms of the case shown in fig. 699.

Clinically there is no recession of the gums beyond a partial disappearance of the interdental papillæ between the mandibular incisors. There was a marked marginal gingivitis, together with a congestion of the whole of the gums. There was a free discharge from the pockets around the teeth. This patient had a well-developed arch and there was marked attrition. The radiograms show that the alveolar process is already involved and that the destruction of bone has advanced to a considerable extent in the mandibular incisor region (fig. 700).

In the case shown in fig. 701 the clinical appearances suggest that the disease is more advanced than in the preceding case. The muco-periosteum was more swollen and congested. The interdental papillæ had quite disappeared, but the gum margin on the labial aspects of the teeth just failed to cover the necks of the teeth.

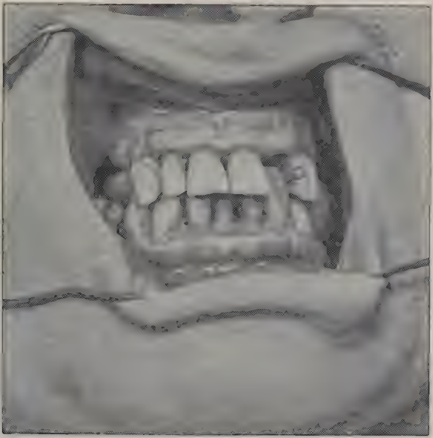

Fig. 701.

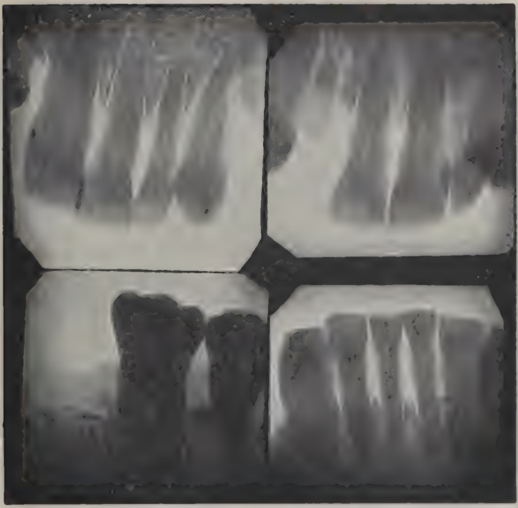

Fig. 702.—Radiograms of the case shown in fig. 701.

The radiograms, fig. 702, show that the bone destruction was much more advanced than the gum recession.

Figs. 703 and 704 illustrate an advanced condition. The radiograms show the extensive destruction of the teeth sockets. Those marked (*a*) and (*b*) also illustrate a point, namely, that the calculus only extends to just under cover of the gum margin. Rarefying osteitis around the roots of a maxillary molar is shown at (*c*) fig.

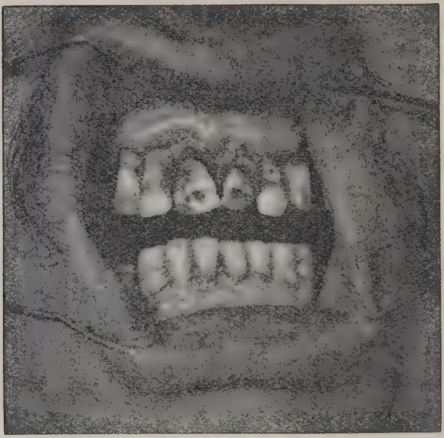

FIG. 703.

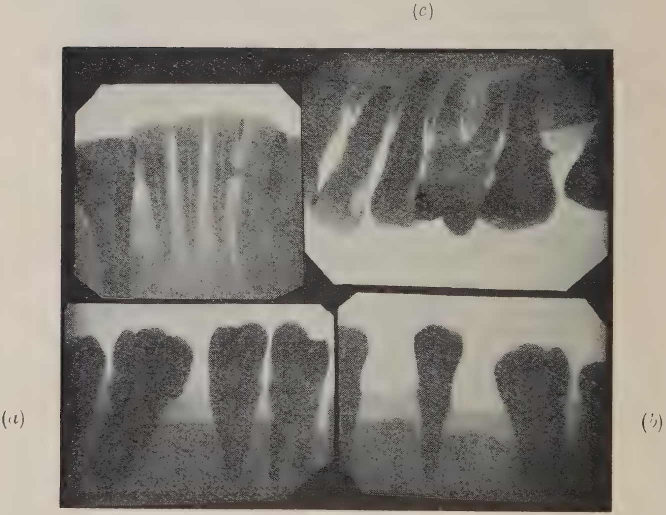

FIG. 704.—Radiograms of the case shown in fig. 703.

704. This case illustrates some features which are of interest from the point of view of prognosis. The patient, a man aged 34, was a compositor by trade, and was subject to dyspepsia. Beyond a well-

defined marginal gingivitis the gums were normal in colour and firm in consistency. The teeth were smothered with calculus; the gum margin was above the necks of the teeth, and the interdental papillæ had disappeared.

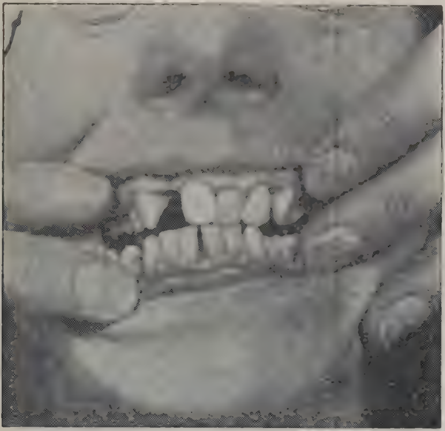

FIG. 705.

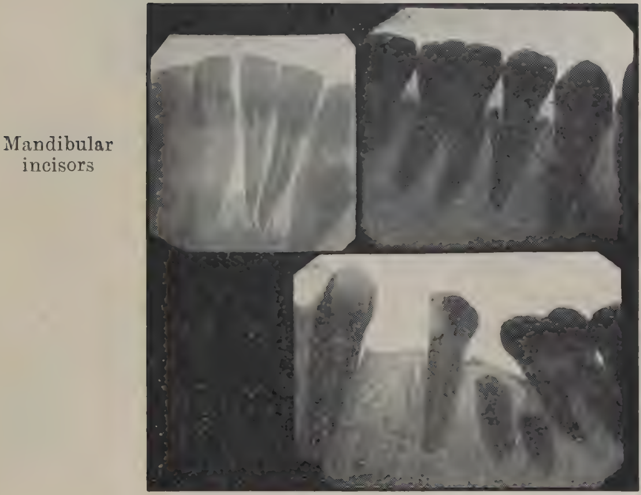

FIG. 706.—Radiograms of the case shown in fig. 705.

In the case shown in fig. 705 the patient was a mouth-breather and complained of bleeding from the region of the mandibular incisors. The teeth had been regularly cleaned. The gums were well up to the level of the necks of the teeth, and the interdental papillæ were not destroyed. There was marked gingivitis around the mandibular incisors where pus was present. An examination with a probe showed that there was extensive destruction of the alveolar process in the region of the mandibular incisors, while in the rest of the mouth the bone was unaffected.

In the case shown in fig. 707 the alveolar process on the mesial aspect of the second incisor has been completely destroyed, and infection of the bone around the apices of the first and second incisors has followed. This patient had a well-defined dento-alveolar abscess, with the pulps of the teeth alive.

(D) SEQUELÆ

The various local and general sequelæ that may arise from the presence of sepsis in the mouth are discussed in Chapter XXV.

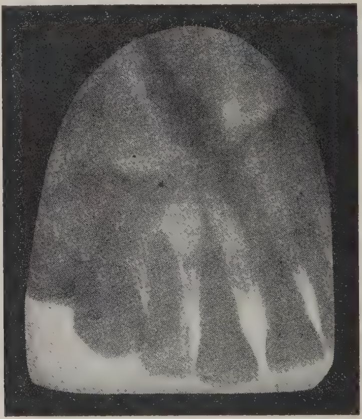

Fig. 707.

But there is one point upon which particular stress must be laid here, and that is that the *absence of objective symptoms is no proof that damage—and possibly irreparable damage—is not in progress.* Patients will harbour sepsis in their mouths for years without apparent harm, but eventually general symptoms are almost certain to appear. The following case is typical:—

A man, aged about 36, at the beginning of 1909 developed a swelling in the left maxilla, and examination of the mouth showed slight necrosis in this region with general suppurative periodontitis, necessitating the removal of all the teeth. His previous history was as follows: His normal weight was about 13 stone, he was an exceptionally fine type of man and had succeeded in carrying off many prizes in important athletic contests.

About the beginning of 1907 he discovered that he was losing weight, and in February, 1909, he weighed only about 9 stone. During this period his mouth had, he said, caused him very little trouble, except that he had neuralgia occasionally, and his teeth had from time to time become loose. All his teeth were eventually removed, and a rapid improvement in his general condition followed. On questioning this patient a very definite history of periodontal disease spreading over a dozen years was disclosed.

This patient had, unknown to himself, been the subject of periodontal disease for years, and for a long period he had been able to combat the absorption of the toxic matter, probably by the production of antibodies, and so remain immune. After a time this immunity had broken down and the toxic material became rapidly destructive to the tissues.

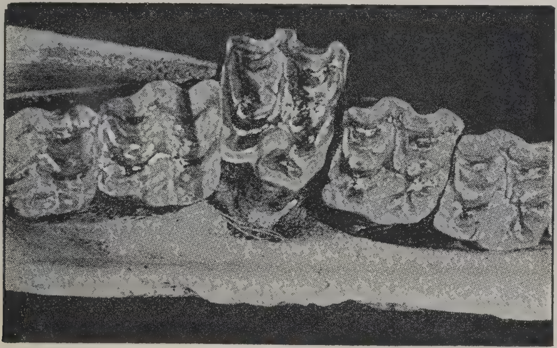

FIG. 708.[1]—Portion of maxilla of horse, showing destruction of the bone around the teeth. The disease is most marked in the neighbourhood of the first molars.

(E) PATHOLOGY

Considerable light has been thrown on the pathology of periodontal disease by a study of the disease in animals.

(1) Horses.—In the course of an examination of nearly 500 skulls of horses which had worked in London it was found that approximately one-third presented some degree of periodontal disease, ranging from a slight destruction of the gingival margin to the most aggravated form of the disease.

The first sign of mischief is a slight injury to the gingival margin, resulting in the destruction of the muco-periosteum filling up the intervals between the teeth. These spaces are usually seen in the maxilla on the buccal side and in the mandible on the lingual side. In the spaces formed, food, &c., collects and undergoes fermentation, leading to the destruction of the adjacent tissues, so that in time a marked space is formed between the teeth into which fodder or other material may become firmly wedged (figs. 708 and 709). As the disease progresses the periodontal membrane becomes more and more involved, leading to extensive destruction of the bone; the teeth loosen, and the infection spreads in the maxilla to the sinus, setting up suppuration, and in the mandible to the body of the bone, causing an abscess.

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[1] From *Trans. Odonto. Soc.*

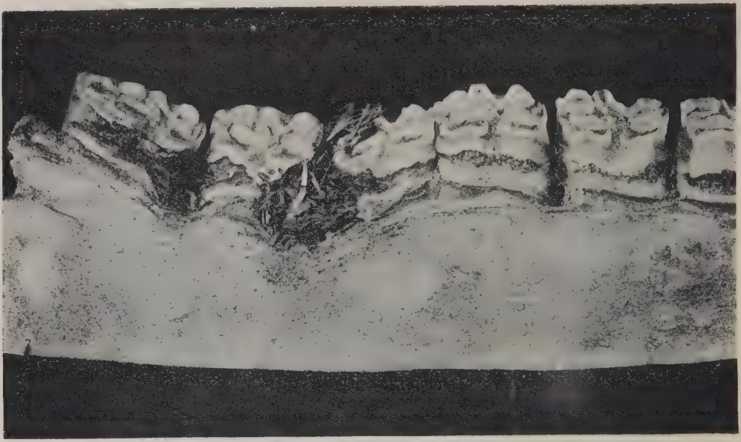

Fig. 709.[1]—Portion of the mandible of a horse showing food packed between the teeth.

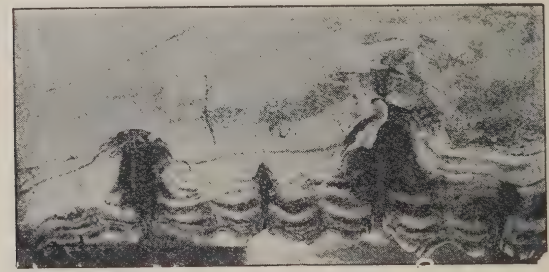

Fig. 710.[1]—Portion of the mandible of a horse with the muco-peristeum in position. The effect of the food packing on the soft tissues is well shown.

If a horse in which the disease is advanced be examined, the muco-periosteum is seen to be inflamed and thickened (see fig. 710) and a profuse muco-purulent discharge will be noticed around the teeth, the breath being extremely offensive. The mandible is much more liable to attack than the maxilla, and, as far as my own observations go, more spaces are met with between the anterior premolars than between the molars, but the spaces formed between the premolars do not apparently set up the same amount of trouble as those found towards the back of the mouth. In the maxilla spaces seem to occur with the greater frequency towards the back of the series. As a result of the spaces the teeth become painful to pressure, and the function of mastication is interfered with, leading in many cases to marked irregular wear of the teeth. In some cases only one or two spaces are seen, in others huge gaps occur between nearly all the teeth.

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[1] From *Trans. Odonto. Soc.*

The incisors may be attacked by periodontal disease. The effect on the incisors is in many respects not unlike that seen in the human subject; the alveolar process disappears; the teeth loosen, become forced out of place, and are finally lost.

The facts that the spaces start on the buccal sides of the maxillary teeth and on the lingual aspects of the mandibular teeth and that the bone destruction is greatest in the region where the food is most liable to collect, would seem to suggest that food lodgment plays an important part in the causation of the disease.

In the horse the disease would seem to be mainly local in origin. The injury of the muco-periosteum is probably due to foreign bodies in the diet. It may arise from food, prepared in the form of chaff or grains of corn, becoming wedged in the "gingival trough." To the fermenting food in the spaces, infection is added from organisms present in, or introduced into, the mouth and from the toxins so produced the tissue destruction proceeds. With the loss of the teeth a nidus for the accumulation of débris, &c., no longer exists, and healing occurs.

(2) Cats and Dogs.—Amongst domestic cats and dogs periodontal disease is extremely prevalent. H. Gray, a veterinary surgeon who has had considerable experience of the disease in these animals, is of the opinion that amongst cats the disease is most frequently seen in highly bred pet animals fed on soft food; the ordinary domestic cat fed on a meat diet keeping comparatively free from the disease. The explanation is that the soft diet clings about the teeth, stagnation areas are formed, and a marginal gingivitis results. This condition is well shown in fig. 712, and the appearance of normal gums in a cat for comparison in fig. 711.

Amongst dogs the pampered lap dogs, and the short-muzzled breeds, such as the pugs and bull dogs, are most subject to the disease, the non-functional teeth, i.e., the incisors, being specially prone to attack. Dogs living on a flesh diet, which gives plenty of exercise to the jaws, are invariably free from the disease.

Amongst cats and dogs, therefore, the disease is evidently closely connected with the soft pap diet which clings about the teeth, and ferments and injures the gingivæ.

(3) Wild Animals.—In animals kept in captivity periodontal disease is of frequent occurrence, and the Museum of the Royal College of Surgeons of England contains an excellent series showing the disease in a wide range of animals, i.e., herbivora, rodents, marsupials, monkeys, the small carnivora, &c.

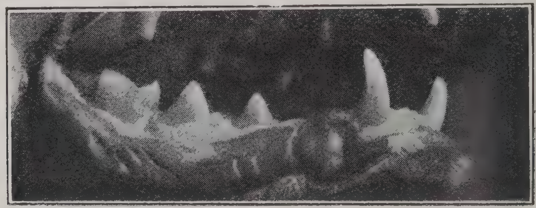

Fig. 711.—Normal gums in a cat.

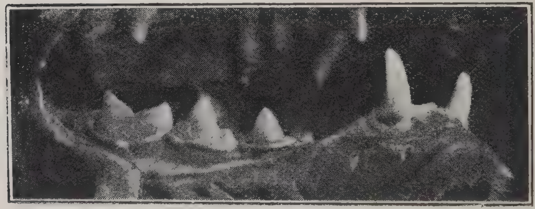

Fig. 712.—Marginal gingivitis in a cat.

In the skulls of captive animals affected by the disease it will be noticed that the bone destruction is usually most advanced around the areas where the greatest force of mastication is exerted and consequently where the soft tissues surrounding the teeth are most likely to be injured. The frequency of the disease in captive animals and the comparative immunity of animals in the wild state, taken in conjunction with the limitation of the disease to the masticating area, point to the disease being closely associated with the character of the food given to captive animals. This food is generally of a softer character, needing less rending and tearing than the food which the animals would obtain in the wild state, consequently, the teeth are less used and the natural cleansing operations are not performed. When captive wild animals are given food of a character similar to their natural food, as in the case of the large carnivores which are fed on a diet of fresh meat, they are almost entirely free from the disease.

Monkeys living in the wild state are not immune to destruction of the alveolar process.

In the **New World Group** Brachyteles shows a considerable tendency to injury of the alveolar bone. In seven out of twelve adult specimens collected from the same district there was lipping or cupping of the alveolar process in varying degrees, and in one specimen several of the teeth had been lost from disease. In Pithecia the variety Satanus seems susceptible, for in six adult specimens from the same district three were affected. The genera Mycetes, Chrysothrix, Hapale and Midas are liable to the disease, but in Uacaria, Callithrix and Douroucollis it is apparently uncommon.

In the **Old World group** periodontal trouble is comparatively common in Semnopithecus. The teeth of these animals are bulbous at the necks, and it is possible that the food is easily caught in the interdental spaces. The incidence of the disease differs in the various species, for example, it is uncommon in *S. obscurus*, but is fairly frequent in *S. cristatus pallata* and *S. entellus anchises*. In Pyrrhus, a variety not particularly liable to the disease, a series of ten specimens from Java all showed recession of the alveolar process, and in four cases definite pockets had formed.

In Macacus destruction of the alveolar process is uncommon, but in fifteen specimens of *M. fascicularis* from Java six showed considerable localized destruction of the bone, and in nine specimens of *M. fuscatus* from Takushima five showed definite pockets.

Of the genus Cercopithecus two hundred specimens were examined and only nine showed much bone destruction, and these were from British East Africa and the Congo region.

The fact that in certain varieties of monkeys the disease is found in some localities and not in others suggests that the presence or absence of the disease is to be attributed to the character of the food available in the particular district. In this connection it is of interest to record that specimens of the Golden Mole (*Chrysochloris aurea*) from the Stellenbosch district in Africa all show early loss of the teeth. Dr. Broom[1] states that this condition is not common in other districts where the Golden Mole is found.

The study of the disease in animals would seem to show that it is purely local in origin, that is, it is due to the lodgment of food; the lodged food undergoes fermentation and putrefaction and the tissues are damaged. This view is supported by the condition of the gums and teeth of cattle in parts of America, where, owing to the penetration of the tissues by the barbed crowns of *Hordeum jubatum*,[1] destruction of the teeth sockets occurs and the teeth are lost. G. Thomson[2] states that periodontal disease is common in horses running almost wild in countries liable to prolonged drought. The animals under these conditions dig up roots, and in chewing the grit and sand injure the gums and start periodontal disease.

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[1] Private communication.

Man.—There are one or two important clinical facts in connection with the disease in man which may assist in the endeavour to trace the pathology of the disease. In *non-mouth-breathers* the disease commences in the molar region and gradually spreads to the anterior teeth, while in *mouth-breathers* the disease commences at an earlier date and often remains for some period limited to the anterior teeth. The commencement of the disease in the *non-mouth-breathers* occurs in the region where lodgment of food is liable to occur, and probably here the initial lesion is an injury to the gingivæ from food débris.

The fact that in *mouth-breathers* the disease commences in the incisor region is instructive. If the mouth of a child affected with mouth-breathing, but with functional molars, be examined, a gingivitis will be noticed limited to the incisor teeth, especially the mandibular ones. The absence of gingivitis in the molar region is due to the fact that the function of this part of the mouth is being properly performed; the friction of mastication and possibly the rubbing of the buccal mucous membrane against the gums removes the superficial layers of epithelium, and stimulates a healthy reaction in the tissues. In the front of the mouth the normal friction of the lips against the gums is absent, the surface epithelium accumulates, together with the débris of food and micro-organisms, and injury results to the gingivæ. As long as mouth-breathing continues the gingivitis persists owing to the constant injury, and eventually the periodontal membrane becomes involved. There is little doubt, therefore, that, with mouth-breathers, the initial stage of the disease is a localized injury to the gingivæ of the anterior teeth.

In considering the pathology of this disease, due weight must be given to *the degree of resistance of the osseous tissue*, as it probably plays an important part in the rate at which the disease progresses. An examination of dried specimens certainly suggests that the more compact the osseous tissue the greater the barrier to the spread of the disease. The question then arises whether the tissues of the tooth socket are as resistant to disease as we might naturally expect them to be. Although no definite data bearing on this point exist, there are certain phenomena which tend to show that the tissues in many people lack normal resistance. It is an axiom that to maintain a part in health the function of that part must be maintained. There is little doubt that in modern times the teeth and surrounding tissues are not called upon to perform their normal functions, with the natural result that the tissues are deprived of a normal blood supply and consequently suffer in vitality. The bone surrounding the teeth is, as we know, a tissue of transient structure, depending for its very existence on the teeth themselves. It is therefore reasonable to assume that there is a very close relationship between functional activity and the resistance of the tissues. With our present diet, functional activity is reduced because foods are so prepared that a very small amount of mastication is required. This loss of the function of the teeth must

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[1] "Dental Surgery," by Tomes and Nowell, p. 648.

[2] *Trans. Odonto. Soc.*, vol. xxxviii, p. 76.

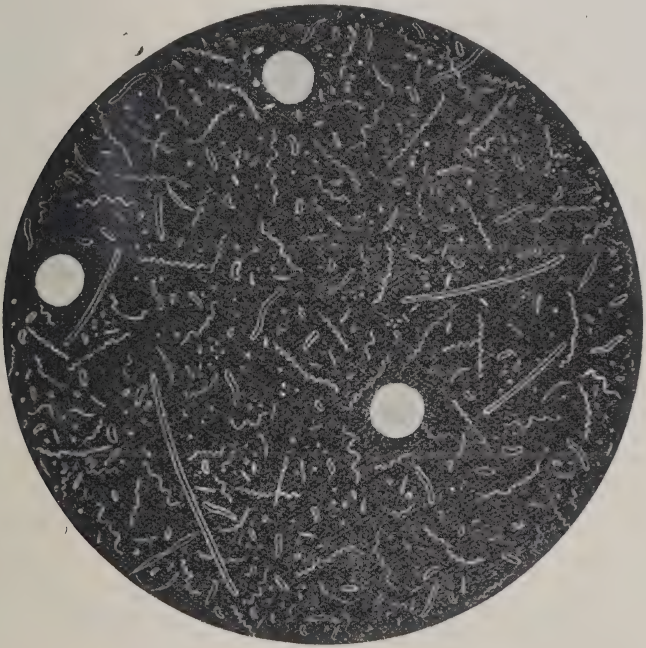

FIG. 713.

seriously affect the structure of the bone forming the alveolar process, and render it less resistant to attack. Clinical observation supports this view.

In mouths which show that the function of mastication is duly performed, the alveolar process is well developed, and if such mouths are attacked by periodontal disease the progress of the disease is not rapid. On the other hand, in individuals who masticate imperfectly, the bony coverings of the teeth are thin and sparse, and the disease when once started progresses rapidly. An examination of maxilla and mandible will confirm this statement, the roots being found in places quite bare of bone, and yet showing no sign of inflammatory changes. It seems probable, therefore, that imperfectly formed teeth sockets play an important part in the progress of the disease, inasmuch as their power of resistance is considerably diminished.

There is another point to be considered in connection with the resistance of the bone, viz., that *any inimical condition affecting the osseous system is likely to show itself in the alveolar process at an early age*, the reason being that, as pointed out above, the alveolar process is a transient structure.

(F) BACTERIOLOGY

The Relation of Micro-organisms to the Disease

Parasitology

A cover-slip preparation made from a case of periodontal disease will reveal a heterogeneous assortment of organisms. In fig. 713 such a preparation is presented, under the dark ground illumination, and W. J. Penfold, who kindly examined the slide, has identified the following types of organisms:—

(*a*) Treponemata of *macrodentium* and *microdentium* varieties, so-called spirochætes of the mouth.

(*b*) Vibrios and spirillary forms.

(*c*) Bacilli in great variety.

(*d*) Filamentous forms.

(*e*) Cocci of various sizes, the grouping of which cannot be determined without cultivation methods.

The large round bodies in the preparation are blood cells.

The discharge from the same pocket was examined by means of transmitted light and revealed the presence of *Entamœba buccalis*. A drawing of four stages of one amœba is reproduced in fig. 714.

In a paper published in the *Dental Record*,[1] F. E. Taylor suggests a classification of organisms associated with periodontal disease under four headings:—

(1) Leptothrices, (2) Spirochætes, (3) Amœbæ, (4) Bacteria.

(1) *Leptothrices.*—These organisms have been investigated by Goodrich and Moseley.[2] They grow in several forms—as threads, as coccoid bodies, as flower heads, as a bottle-brush shaped form, and as fusiform bodies. They are found in profusion in the pockets and on the teeth removed in the treatment of the disease.

(2) *Spirochætes.*—The most important work on spirochætes in connection with periodontal disease has been done by Drew and Griffin.[3]

They found at least six species, viz., *Spirochæta buccalis*, *S. vincenti*, *S. refringens*, *Treponema macrodentium*, *T. microdentium* and *T. mucosum*. The authors adopt the term Spirochæte for an elongated sinuous organism provided with an undulating membrane but possessing no flagella, the term Treponema for a sinuous organism with no undulating membrane but with terminal flagella.

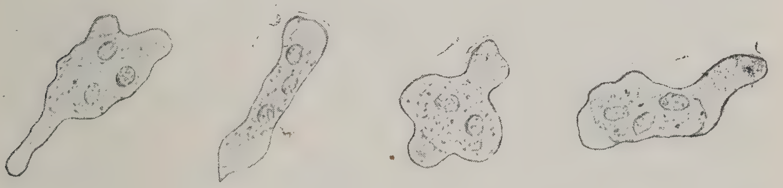

FIG. 714.

In addition to the above the authors noticed two flagellate organisms which they believed had not been previously described, one of these organisms bearing a striking resemblance to the trypanosomes.

(3) *Amœbæ.*—Recently Barrett and Smith, Bass and Johns, and others have called attention to the frequency of the association of amœbæ with pyorrhœa alveolaris, and it has been claimed that the cause of periodontal disease is *Entamœba buccalis*. In 1849 Gros first observed amœbæ in the mouth. Sternberg (1862) found them in the sordes about teeth.

The active forms of *A. buccalis* are from 6 μ to 32 μ in diameter;

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[1] May 1, 1918.

[2] *Journn. Roy. Micro. Soc.*, October 18, 1916.

[3] *Ibid.*, April, 1917.

they average about 15 μ. They have a distinct ectoplasm which is well seen when the organism is in motion. The organism is hyaline and refractile. The endoplasm is granular and shows many food vacuoles, but no contractile vacuole. The nucleus is well defined and shows a thick greenish membrane containing a great deal of chromatin. A small centriole is situated near the centre of the nucleus. The motility is sluggish and the pseudopodia are blunt. The cysts of the organism have never been seen in the mouth.

A causal relationship of *A. buccalis* to periodontal disease was claimed on the grounds that:—

(*a*) It was always present in the disease.

(*b*) The administration of emetin and the application of the drug to the pockets cured the disease.

The points against *A. buccalis* being the cause are that:—

(*a*) It is frequently found in mouths with healthy gums.

(*b*) Emetin does not cure the condition, although it may remove the amœbæ if the drug is applied locally.

(*c*) The *A. buccalis* is not always present.

Indeed, the whole of the evidence brought forward by those who wish to establish its causal relationship with periodontal disease is unconvincing and it is extremely doubtful whether any such relationship exists.

(4) *Bacteria.*—The bacteria present may be Streptococci (always), *Staphylococcus albus* and *aureus*, *Micrococcus catarrhalis*, vibrios, fusiform and other bacilli.

In a series of thirty-three cases recorded by Eyre and Payne[1] the following organisms were regarded as responsible for periodontal disease:—

	Cases.
Micrococcus staphylococcus pyogenes aureus	2
,, *catarrhalis*	9
,, ,, and *Streptococcus pyogenes longus* ...	11
Streptococcus pyogenes longus	7
,, *lanceolatus pneumoniæ* (pneumococcus)	4

In a communication to the *Dental Cosmos*[2] L. S. Medalia gives the results of his study of 115 cases. He found that the organism most frequently met with was the pneumococcus (*Streptococcus lanceolatus pneumoniæ*), 107 times out of 115. The results of his investigation are as follows:—

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[1] *Proc. Roy. Soc. Med.*, vol. iii (Odonto. Sec.), p. 36.

[2] *Dental Cosmos*, 1913, p. 24.

	Cases.
Pneumococcus strepto-lanceolatus pneumoniæ	26
,, and staphylococcus	67
,, and streptococcus	3
,, staphylococcus and streptococcus	10
,, and *Micrococcus catarrhalis*	1
Staphylococcus and ,, ,,	2
Staphylococcus aureus	2
Streptococcus and staphylococcus	1
Sterile	3

It will be noted that the bacteria found in the pus from cases of periodontal disease are identical with those which are responsible for ordinary suppuration in other parts of the body.

To sum up, investigations into Parasitology afford no evidence that periodontal disease is caused by a specific organism.

Résumé.

A general survey of the morbid anatomy, pathology and clinical appearances of periodontal disease leads to the conclusion that the initial lesion in man is injury to the gingival margin, which results in the formation of a stagnation area. In this area material collects from which toxins are formed, and the tissue changes which follow are identical with those produced by periodontal disease in the lower animals. In the area immediately beyond the ulcerating surface—for as such it must be regarded—the tissues react and form a protective barrier, and the progress of the disease is governed by the efficiency of this barrier. The reaction of the tissues depends upon:—

(*a*) Their inherent vitality.

(*b*) The degree of functional activity—the greater the flow of lymph through the area the greater will be the accumulation of antibodies.

(*c*) The severity of the infection.

In many cases of periodontal disease, more especially in young adults, the natural defence of the tissues suffices to prevent the undue absorption of toxins or organisms viâ the bone. But the discharge from the mouth is swallowed with the saliva and consequently the gastric mucous membrane is continually being damaged. Sooner or later the defence of the tissues at this part breaks down and eventually the whole intestinal tract becomes involved.

The tissues of many patients seem to be incapable of raising an effective barrier even in mild cases. In cases where the natural defences of the tissues around the teeth are inadequate the toxins pass directly into the general circulation.

(G) ETIOLOGY

Considerable diversity of opinion exists as to the cause of chronic general periodontitis.

In reviewing the pathology of the disease in animals it has been shown that the lesion is caused by injury from the food. When cats and dogs are fed on a diet of fresh flesh, their natural food, they are invariably free from the disease, but as soon as soft pap food is substituted the animals become a prey to the disease. In the horse the disease can clearly be traced to injury from the food, the particular form in which the food is given being responsible for the injury. Under natural conditions horses feed upon grass which is torn up in long strands and in a pliable state, and is masticated and disposed of without injury to the soft tissues. Under "civilized" conditions horses frequently cannot be put out to grass and the food is often given in the form of hay and straw (chaff) cut up into short lengths. Chaff in short stiff lengths is very likely to cause injury to the muco-periosteum through being pressed into spaces between the teeth. This view of the causation of the disease in horses is supported by the fact that the disease is prevalent wherever the conditions are such that fragments of thorn become mixed with the food. Similarly, as previously mentioned, cattle in parts of America are subject to the disease owing to the penetration of the tissues by the barbed crowns of *Hordeum jubatum*. In the horse the disease is clearly to be attributed in a very large measure to the physical character of the food.

In man, too, *the evidence points to the disease being started by injury of the gingival margin from food débris, or by the local action of toxins as seen in the marginal gingivitis of mouth-breathers.*

The prevalence of the disease is probably due to the character of the diet of the present day. Much of our food is now prepared in such a manner that it readily accumulates around the teeth and is of a character which easily undergoes fermentation. The food thus prepared requires but little mastication, with the result that the tissues in and around the teeth are deprived of an adequate blood supply and are thus rendered less resistant to attack.[1] As soon as the disease has started, the formation of abnormal pockets favours the accumulation of débris, thus increasing the basis of infection and so accelerating the action of the toxins.

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[1] Evidence in favour of this is shown in a series of skulls of Londoners of the sixteenth and seventeenth centuries. Periodontal disease in the region of the molars is extremely common in the skulls, but the disease is chronic in character and the bone shows distinct reaction to injury. In the majority of these skulls the function of mastication was efficiently carried out as is shown by the attrition of the teeth.

Attention has been drawn to the intimate **relationship between periodontal disease and mouth-breathing,** and the increase in the number of individuals who are mouth-breathers has, undoubtedly, added to the incidence of the disease.

The view here expounded that stagnation of food is the primary cause of periodontal disease is supported by an observation made by S. Colyer[1] on the teeth of the Barotze, a tribe living in North-West Rhodesia. Their diet is mainly of a carbohydrate character to which milk, fish and meat are added as savouries. They do not clean their teeth and suffer from marked periodontal disease. On the other hand, the native police of the district, who are drawn from Zulu, Central African and Arab strains, although eating the same type of foods, have very little periodontal disease. The police clean their teeth with sticks twice a day and always after the evening meal.

(H) TREATMENT

In the section on the morbid anatomy and pathology of the disease, it was pointed out that the formation around the teeth of "pockets," which inevitably become stagnation areas, is the outstanding feature of the disease. Until these "pockets," or stagnation areas, have been eradicated, it does not seem reasonable to claim that a cure has been effected, and as it is almost impracticable to eradicate them actual cures of periodontal disease are rare, though well-directed treatment may keep the disease in check. Reference has also been made to the important rôle which mouth-breathing plays in the promotion of the disease. It has also been shown that the progress and severity of the disease are greatly influenced by the degree of resistance offered by the tissues.

Treatment, therefore, should be directed towards promoting efficient drainage, raising the resistance of the tissues and ensuring proper nasal breathing.

With regard to the breathing I am firmly convinced that in all cases of mouth-breathing, even if the patient is addicted to this habit for a few hours a day only, there is very little hope of checking the disease; moreover, in such cases the general symptoms seem more pronounced. It is essential, therefore, to ensure proper nasal breathing. Where the patient breathes by the mouth the nasal cavity must be examined and any obstruction removed. Some patients persist in the habit of mouth-breathing after a free nasal passage has been obtained. The habit can, however, often be overcome by the use of an oral screen. This appliance is made as follows: Models of the teeth and gums are obtained, the models being fixed together with the teeth slightly open at the front, to simulate the relation of the teeth when the mandible is at rest. The necessary dies and counterdies are obtained and a piece of aluminium is struck to fit the surface of the teeth and gums. The appliance is inserted just before going to rest. The results obtained are most satisfactory.

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[1] *Dental Record,* October, 1920.

The **therapeutic measures to be adopted** may be divided into (1) Local and (2) General.

(1) Local Treatment

Local treatment consists in the promotion of asepsis as far as practicable by securing efficient drainage. Efficient drainage relieves the tissues of the constant injury arising from the toxic matter around the teeth and the tissues react more readily. It may be confidently affirmed that the more thoroughly the pockets are kept free from sepsis, the greater will become the prospects of staying the progress of the disease. In theory efficient drainage would seem an easy matter to establish; in practice, however, such is not the case. The local remedies employed should be directed towards:—

(*a*) Freeing the teeth from salivary calculus and other débris.

(*b*) Reducing the depth of the pocket.

(*c*) Cleansing the pocket.

(*d*) Massage of the gums.

(*a*) The removal of salivary calculus allows the pockets to drain more freely and facilitates irrigation of the pockets. The scaling must be done thoroughly and special care taken to remove any calculus in the interstitial spaces. Where there is much gingivitis it is advisable to delay the scaling until the gingivitis has been reduced by appropriate treatment, and the general resistance raised by improving the general health. The operation of scaling can then be carried out more efficiently and with less laceration of the tissues.

(*b*) In considering methods for reducing the depth of the pockets, it must be remembered that the pockets are deepest at the most inaccessible parts, i.e., in the interspaces. The regular use of astringents will often produce good results. Tannic acid in the form of a powder may be used and should be rubbed into the gums for two minutes once a day, the treatment being continued for at least two months. If at the end of this period the gum margins have shrunk, the application may be reduced from once a day to twice a week. As tannic acid is liable to leave an indelible stain on linen, patients using it should be warned against wiping their hands on linen.

The free removal of the redundant gum with scissors and small knives is an excellent method of reducing the depth of the pocket, especially where there is considerable destruction of the membrane on the labial aspects. The actual cautery is another useful method of destroying the gum margins; this method is especially useful in the interproximal spaces.

(*c*) Regular cleansing of the pockets and interproximal spaces by the patient is an essential part of the local treatment. First, the spaces between the teeth must be freed of food débris by means of "floss silk"; the gums should then be well squeezed between the thumb and first finger with a downward pressure on the upper teeth and an upward pressure on the lower teeth. The next step is to "irrigate the pockets." If the irrigation can be easily carried out, no special fluid is necessary and a free flushing with sterilized water would be effective. The most efficient method is to flush the pocket with peroxide of hydrogen (vols. x), using a hypodermic syringe. The needle of the syringe is passed well into the pocket and gentle pressure exerted. The use of force is to be deprecated as it is essential that any granulation tissue that may be present should not be broken down. But as a hypodermic syringe cannot be readily manipulated by patients it is generally necessary to try an easier, if less efficient, means of irrigation.

A good plan is to have the pockets wiped out with a wisp of cotton-wool dipped in hydrogen peroxide, the cotton-wool being wound round a fine broach. It is necessary to give patients very precise instructions. The broach should be of the type ordinarily used for root canal dressings. The method of winding the wool on the broach should be demonstrated. The following plan is suggested: Spread a wisp of cotton-wool along the palmar surface of the terminal phalanx of the first finger of the left hand; place the broach on the centre of the wool; fold the cotton-wool over the broach; bring the thumb on to the broach and then run the thumb with the broach up the palmar aspect of the first finger; the fragment of wool over the point should then be turned down so as to prevent the point sticking through.

Such detailed instructions may seem hardly necessary, but experience teaches that the success of this method of treatment depends in a large measure on the skill of the patient in twisting the wool on to the broach.

The patient should be shown exactly where and how to apply the peroxide of hydrogen and instructed to pay special attention to the irrigation of the spaces between the posterior teeth. The hydrogen peroxide to be used should be poured into a small receptacle, and any left unused should be thrown away and not returned to the bottle. The pockets should be cleansed at least once a day, the best time being shortly before retiring for the night. If the patient will only carry out this method of cleansing the spaces thoroughly and regularly, a marked improvement may be confidently anticipated.

(*d*) Massage of the gums by regular rubbing with the fingers will assist in improving the condition of the gum margins.

(2) General Treatment

General treatment, directed towards the removal of systemic intoxications, and a general improvement in health. The nearer the health approaches to the normal standard the greater becomes the resistance of the tissues and their power to react. An impairment of the general health implies a lowering of the resistance of the tissues and of their power to react, and it is very important therefore that steps should be taken to improve the general health as far as possible. But this part of the treatment belongs to the province of the general medical attendant.

Vaccine-therapy has been freely used during recent years. This method of treatment aims at assisting the tissues to defend themselves against the action of bacteria and their products. The method of procedure suggested by J. W. Eyre[1] is as follows: "The patient is instructed to grasp the lip opposite the affected teeth with the forefinger and thumb of each hand and draw it away from the gums; in some cases a small roll of absorbent cotton-wool is packed into the sulcus between the alveolar process and the lip. The gum margin is next wiped with a sterile swab of cotton-wool mounted on the end of a stick, and the gum itself dried with a second sterile swab. Then with another swab firm pressure is made on the gum over the root of the tooth. The first drop or two of pus that exudes is mopped up with a third sterile swab and the pressure continued, and the pus that next exudes is collected on still another sterile swab, or by means of a stout platinum needle. This pus is employed for the purpose of making coverslip films. Finally, more pus is expressed in a similar way and used to inoculate tubes of nutrient media."

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[1] *Proc. Roy. Soc. Med.*, vol. iii (Odonto. Sec.), p. 34.

The most satisfactory method is to extract a tooth when this is practicable, for preference a molar, and take a culture from the space between the roots or from near the apex of the tooth. Pure cultures of the various micrococci present are then obtained secundum artem. The patient's serum is next examined with the view of obtaining evidence of the presence of antibodies to the organisms isolated. In this connection, opsonins, amboceptors, and agglutinins are the most useful antibodies, in the order mentioned. The organism towards which a low index (0·5 or lower) or a high index (1·3 or higher) is recorded is usually regarded as the possible origin of infection and from this organism a vaccine is prepared. (K. W. Goadby suggests that if more than one organism shows a low index a mixed vaccine of the several organisms should be obtained.) If two or more organisms are associated, as is frequently the case, a separate vaccine of each should be prepared, and if subsequent observations of the index towards each bacterium are recorded, the dosage of each vaccine may be modified as may be necessary. In all cases, and particularly if improvement is slow, further bacteriological examination of the case should be made from time to time.

The vaccines are prepared in doses of varying strength, each dose being placed in a small sterile glass bulb. The strength of the dose required depends upon the responsible organism. For the infecting micro-organisms which are most commonly encountered Eyre recommends doses as follows:—

	Millions.				
Micrococcus catarrhalis if apparently the sole infecting organ	5	10	25	50	
M. catarrhalis associated with streptococcus	10	25	50	75	100
M. paratetragenus	10	25	50	—	
M. pyogenes aureus	50	100	250	500	
Streptococcus lanceolatus pneumoniæ (with which *Streptobacillus malæ* (Goadby) is probably identical)	5	10	25	50	
S. pyogenes longus	5	10	25	50	
Bacillus pneumoniæ (Friedlander)	5	10	50	100	
B. pyocyaneus	10	50	100	250	

The injection of the vaccine must be carried out under strictly aseptic precautions.

As to the value of vaccine therapy in periodontal disease there is extreme divergence of opinion. Vaccine therapy aims at assisting the tissues to defend themselves against the action of bacteria and their products. It is essential for success, therefore, that we should know the causative organism of the disease which has to be treated. There is reason to believe that periodontal disease is not caused by a specific organism; but if a specific organism is responsible for the disease it has not yet been identified. The treatment of periodontal disease by vaccine therapy therefore is not likely to be successful because the most important requirement is not met. It may be urged in favour of vaccine treatment that the infection in the pockets is causing local injury, and that vaccines will check the injury by raising the resistance of the tissues in the neighbourhood of the tooth. The difficulty here lies in the fact that the infection is invariably mixed, and the vaccine therapist, if he desires to effect a thorough cure, must needs prepare a vaccine of all the organisms found. As this is not possible it is the practice to use a vaccine of the predominant organism, or perhaps of two of them, and, under these conditions, the treatment is necessarily incomplete. But, granting that vaccine treatment is occasionally successful, the pockets still remain, and no amount of vaccine treatment will remove them.

Apart, however, from any consideration which may be regarded as more or less theoretical, the question arises whether vaccines lead to good results in the treatment of periodontal disease. I have had personal experience of many cases of periodontal disease which were treated with vaccines, and in no single instance was a cure effected and in only a few cases could I detect any improvement.

When vaccine treatment is carried out concurrently with local remedies and improvement results, it is extremely difficult adequately to assess the amount of improvement which should be ascribed to the local measures on the one hand and to the vaccines on the other. It is the general experience that the majority of cases treated with energetic local measures will show a rapid improvement.

In the treatment of the general condition arising from mouth infection vaccines may undoubtedly be extremely useful.

In papers advocating the treatment of periodontal disease by vaccines it is constantly claimed that a large percentage of the cases have been cured. Manifestly much depends upon the exact meaning placed by the practitioner on the word "cured," and reference to this point has already been made (see p. 555). Eyre and Payne[1] do not take the view there expressed, but class as "cured" all cases where "the affected teeth are firm so that mastication is painless and the mouth comfortable, no pus can be expressed from the sockets, the pains and other symptoms of ill-health have disappeared, and the patient feels 'quite well.'" In such cases the patients are, in my opinion, relieved only and not cured. The pockets remain and recurrence of trouble is only a matter of time.

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[1] *Proc. Roy. Soc. Med.*, vol. iii (Odonto Sec.), p. 39.

The method of treatment to be adopted in a case of periodontal disease will depend upon the conditions present.

(*a*) **Cases Favourable for Treatment**

A case may be regarded as favourable for treatment if the following conditions are found:—

(*a*) The pockets around the teeth are shallow.

(*b*) The arch is well developed, and the function of mastication is efficiently performed.

(*c*) There are indications of recuperative powers on the part of the patient.

(*d*) The patient is a nose-breather.

As the pockets, which are the real cause of the trouble, cannot be removed, treatment resolves itself into a question of drainage. The more thoroughly the pockets are cleansed, the greater will be the chance of staying the progress of the disease. The teeth must be thoroughly scaled, and the patient instructed to carry out the following daily routine:—

(*a*) Pass silk between the teeth to free the spaces of débris.

(*b*) Squeeze the gums so as to expel as much material as possible from the pockets.

(*c*) Brush the teeth and gums thoroughly with a stiff brush.

(*d*) Irrigate each space with peroxide of hydrogen, as suggested on p. 557.

(*e*) Twice a week apply to the pockets a 2 per cent. solution of iodine in alcohol.

These simple measures, if faithfully carried out, will suffice to arrest the disease in favourable cases. I have tried raising the resistance of the tissues by means of vaccines and Bier's method of congestion, but I am not satisfied that these cases showed greater improvement than others where the treatment was limited to irrigation. Thorough cleanliness of the pockets is the keynote in treatment, and, if this is achieved, an arrest in the progress of the disease may be expected.

In cases where there are deep or even moderately deep pockets between the molars, it is often a good plan to isolate the second molars by the removal of the first and third molars.

(*b*) **Cases not Favourable for Treatment**

Cases which are not favourable for treatment are those which show well-marked signs of rarefying osteitis with general and local conditions indicating that the tissues possess little recuperative power; also all cases of persistent mouth-breathing. It will be convenient to group these cases under two separate headings, viz:—

(i) Cases unassociated with apparent symptoms; and

(ii) Cases in which a causal relationship to other diseases has been established.

(i) Cases unassociated with apparent symptoms

As regards cases falling under this heading, there are certain points which must be kept clearly in mind in endeavouring to arrive at the right line of treatment. Although efficient irrigation may check the discharge from the tissues, and some advantage may be gained in an attempt to raise the resistance of the tissues by the aid of auto- or hetero-inoculation, all such efforts will fail to stop the progress of the disease. In these circumstances the question arises whether it is justifiable to continue a course of treatment which, at the best, can do no more than slow down the progress of the disease. My own view is that such a course of treatment cannot be justified for two reasons: (1) Because a potential source of infection remains which may become active at any moment, and (2) because the destruction of the alveolar process is proceeding and thus increasing the difficulty of providing artificial dentures which will be efficient and comfortable.

(ii) Cases in which a causal relationship to other diseases has been established

In this class of case it is absolutely necessary that the dental sepsis should be completely removed. After reviewing the cases which have come under my notice during the last ten years and carefully considering the results of different methods of treatment, I am satisfied that the removal of the affected teeth at the earliest opportunity is the right course to adopt, and that any other line of treatment will prove to be unsatisfactory. A typical example of this class of case is as follows: A young adult is suffering from rheumatoid arthritis and the mouth shows signs of general periodontal disease accompanied by rarefying osteitis in a marked degree. The case is one in which the potential source of trouble—that is, the pockets—cannot be removed by treatment. The choice here lies between retaining the teeth and running serious risk of an aggravated arthritic condition on the one hand, or, on the other hand, removing the teeth and ensuring useful joints. In my opinion, the latter course alone can be justified, as artificial dentures can be provided, but not new movable joints.

In carrying out extraction in these cases the following course should be adopted: The mouth is made as healthy as possible by thorough irrigation of the pockets with hydrogen peroxide. The premolars and molars are next removed and the mouth is allowed to heal. Models of the mouth are then taken with the incisors in place and bites are obtained. The advantage of proceeding on these lines is that you avoid the difficulty which would be experienced in gauging the correct height of the bite after the removal of the front teeth. The anterior teeth are then removed and dentures inserted as soon as possible. The number of teeth which can safely be removed at one sitting depends largely upon the individual case. Where the "power of repair" is at a low ebb the extractions must be carried out by easy stages, but where there is ample "power of repair" the extractions may be carried out more expeditiously. I incline to the view that extensive extractions at one sitting should be avoided unless there are special reasons for adopting that course. It is said that trouble in the bone is likely to follow extensive extractions in these cases unless the resistance of the tissues is first raised by a course of vaccine treatment, but that is not my experience. I am disposed to think that, where trouble in the bone occurs as a result of extractions, it is almost always due to the damage inflicted on the tissues by the operation. A rise in temperature seldom follows the extractions if the mouth is kept clean. Occasionally a rise in temperature does occur, as is well shown in fig. 715. The patient was suffering from a corneal ulcer, and the removal of each batch of teeth was followed by a rise in temperature.

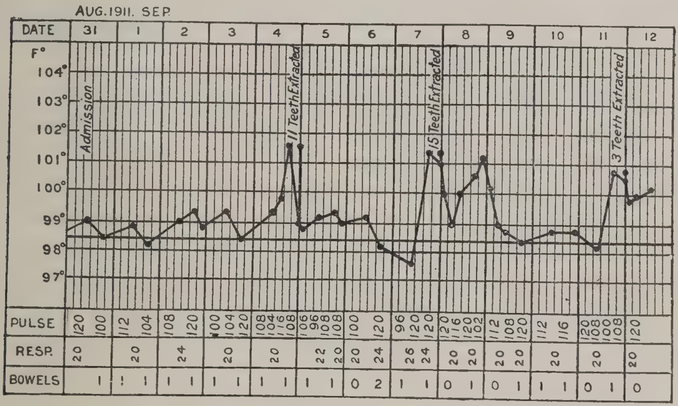

FIG. 715.

In some cases it is found that the removal of a first batch of teeth causes very little general disturbance, whereas the removal of a further batch is followed by a considerable rise of temperature. As an example the following may be quoted: A man, aged about 48 years of age, had lost in five years two and a half stones in weight. There was marked periodontal disease. The $\left|\frac{4567}{4567}\right.$ were removed with no apparent septic sequelæ, subsequently $\underline{876}\,|$ were extracted, and within four hours there was a definite rigor with the temperature rising to 101° Fahr.

In cases where general trouble is traceable to the mouth it has been my practice to retain the anterior teeth provided that the bone destruction is slight. The argument in favour of retaining the teeth in these cases is that the pockets around the anterior teeth are easily accessible and can be thoroughly irrigated by the patient.

Experience of these cases has taught me, however, that if the patients are mouth-breathers it is only a matter of time before extraction becomes imperative. It would therefore seem sounder treatment to remove all the teeth and thus make certain that the patient is freed from dental sepsis.

I am well aware that treatment by free extraction of all teeth which are the source of sepsis, as suggested above, is opposed to the teachings of many practitioners. With those who hold that local treatment will often result in a removal, or at least an improvement in the general condition, I fully agree, but—and this is the important fact—the source of sepsis has not been eradicated. The sepsis may possibly be lessened in degree, but nevertheless it remains and must continue to damage the tissues slowly but surely. The damage to the tissues is progressive, and when, through the loss of the teeth, a natural cure of the teeth is effected, the damage of the tissues may be irreparable. Dental practitioners cannot be justified in allowing such a condition to be brought about, and it is our duty to place clearly before the patients the risks they run.

Before leaving the question of treatment, reference must be made to ionic medication in the treatment of periodontal disease. My colleague, Norman G. Bennett, of whose judgment I have a high opinion, adopts the following technique in treatment: The teeth are freed of calculus and the mouth rendered as healthy as possible. It is not necessary—in many cases it is not possible—to remove all calculus as a preliminary to treatment; the process can be more completely accomplished during the course of treatment; indeed, small areas of marginal gingivitis which do not respond will often be found to be covering a small deposit of undiscovered calculus. A 5 per cent. aqueous solution of zinc chloride is generally employed, but salts of copper—such as the sulphate—or of silver, may be used; the electrode may be of platinum, or of the base metal of which the salt is being applied. A few contiguous teeth should be isolated and kept moderately dry by means of napkins, wool rolls, or bibulous paper. Absolute dryness is not necessary, but too much moisture will not only dilute the drug unduly, but also allow the current to pass superficially instead of through the tissues. The current having been turned on and the rheostat control advanced a short distance, the positive electrode, previously wrapped round with a small quantity of cotton-wool, should be dipped in the solution and applied to the gum at least a quarter of an inch from the neck of the tooth; it should then be slid carefully over the gum until the neck of the tooth is reached and passed down into the pocket round the tooth. The most important parts are the approximal pockets. It is usually convenient to treat about half a dozen teeth at a time, dealing first with the labial or buccal aspects and the approximal pockets, and completing on the lingual aspects. The amount of current registered with any given voltage varies inversely with the resistance of the body. This resistance itself varies with different patients and with the same person at different times. The amount of current that can be tolerated is usually from one to five milliamperes. It will usually be found that a current of one milliampere is not felt at all; more than five cannot usually be borne, except perhaps in the molar region. A current of three milliamperes is usually sufficient for therapeutic effect, and tolerable to the patient.

A current of low electro-motive force having been tried at the outset, it can be gradually raised by moving the rheostat control until sufficient is obtained. It should be remembered that most pain will be felt when the needle is first applied (the "make" of the current), less when it is broken, and least of all during the passage of the current, so long as the electrode is stationary. That is why the needle should, every time it has been dipped in the solution, be first applied to the gums and then moved to the tooth. If a large drop of liquid is hanging on the needle a considerable amount of pain may be felt at the first contact. Care should be taken to move the needle smoothly from one tooth to the next without making contact or even altering the area of contact more than necessary, because the current is felt more severely when passed through a small area than a large. When the teeth are very sensitive it is sometimes necessary to apply the needle first and then gradually turn the current on from zero; in this way pain may be minimized.

By taking groups of teeth in succession the whole mouth may be treated in about three-quarters of an hour, but it is often desirable to spend the greater part of the time over the most seriously affected teeth, three or four minutes being devoted to a single tooth. The only visible sign noticeable is a slight whitening of the edge of the gum, and a kind of white deposit spreading from the edge. It is only very rarely that any sensation is felt in the hand of the patient holding the negative electrode. It is desirable, however, that rings should be removed.

The application should be repeated every second or third day for a fortnight, then less frequently until about ten or a dozen applications extending over five or six weeks have been made. In this period it will be possible to judge results, and if considerable improvement cannot be obtained in that time or even less, it is not likely to be gained at all.

The action of ionization is probably to stimulate the soft tissues around the teeth and sterilize the contents of the pockets, the drug exercising an astringent action. It is questionable whether it possesses advantages over the local treatment recommended on p. 556, but there is little doubt that deeper penetration of the tissues is obtained than by any kind of mere application of antiseptics. It should be understood that in cases at all advanced, or in which pockets remain after treatment, no cure can be expected; and that in all cases subsequent care on the part of the patient is essential. One constantly hears that the patient has undergone ionic treatment and is cured, but on inquiry no regular treatment is being carried out. In these patients the " pockets " around the teeth still exist, and if not regularly cleansed the disease must progress.

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CHAPTER XVIII

Diseases of the Gums and Adjacent Mucous Membrane

Hypertrophy of the Gums—Gingivitis—Stomatitis—Leucoplakia—Pemphigus—Purpura—Scurvy—Leukæmia—Perforating Ulcer—Tubercle—Syphilitic Lesions—Aneurism

(A) HYPERTROPHY OF THE GUMS

True hypertrophy of the gums consists in a general overgrowth of that portion of the gums which covers the alveolar process. Good examples of this disease are represented in figs. 716 to 719, which delineate the mouths of two brothers, aged 7 and 9, respectively, who came under observation. In a younger brother seen five years later at the age of six a similar condition was found, the thickening, according to the father's statement, having begun as the teeth erupted. The hypertrophied gum in all three cases was normal in colour, of a dense fibrous character, and was more marked in the front of the mouth. The mouths were clean and there was no tendency to bleed and no discharge. The boys were intelligent and there were no lesions elsewhere. The two parents and the two sisters were free from any abnormality of the gums.

The hypertrophy of the gums would seem to start with the eruption of the teeth. In a case quoted by Erichsen, the affection showed itself at the age of seven months, during the eruption of the incisors, and in another case, quoted by Heath, the swelling of the gums commenced at two years of age with the eruption of the deciduous molars. If left untreated, the hypertrophy increases, and in time the teeth become completely hidden.

The hypertrophy may be limited to a particular region; for example, in a case recorded by A. Evans[1] the trouble was confined to the molar region.

W. W. James has recorded[2] a case where hypertrophy of the fibrous tissue of the gingival muco-periosteum occurred with the eruption of each tooth of the deciduous and permanent dentitions.

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[1] *Proc. Roy. Soc. Med.*, vol. i (Odonto. Sec.), p. 125.

[2] *Lancet*, July 26, 1919.

A **microscopical examination** made by C. S. Tomes of one of Heath's cases showed that "the growth closely resembled that of the small polypi which are sometimes found occupying the cavity of the carious teeth; it was true hypertrophy of the gum, and chiefly of the fibrous portion. It sprang from the periosteum round the neck of the tooth just within the margin of the alveoli. From this point emanated a dense stroma of interlacing fibres, covered by a thin mucous and epithelial layer."

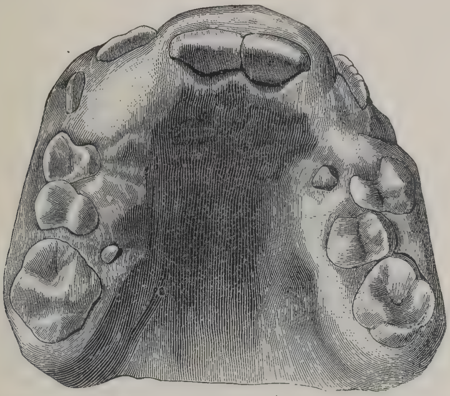

Fig. 716.—F. S., aged nine years (maxilla).

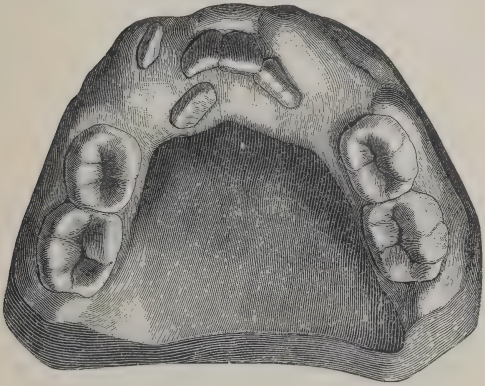

Fig. 717.—F. S., aged nine years (mandible).

In many of the accounts given of the disease, the gums are described as being darker than the normal, and as bleeding freely at the lightest touch. This condition of the gums is due to inflammatory reaction in the hypertrophied tissue from sepsis in the spaces between the teeth and gums.

The combination of hypertrophy of the gums with superadded inflammatory reaction may give rise to a most distressing condition of which the following case, recorded by Heath,[1] is a good example. The patient was a man, aged 26, and, four years before being seen, he had consulted a surgeon, who cut away the hypertrophied gums of both jaws and afforded considerable relief to the patient. Three months later the growth had recommenced, and, although it had made steady progress for three years, the patient sought no further advice. On admission to hospital, the external deformity was well marked, and, on opening the mouth, the gums of both jaws were seen to be enormously hypertrophied, most of the teeth being loose and displaced (fig. 720). The palate at a

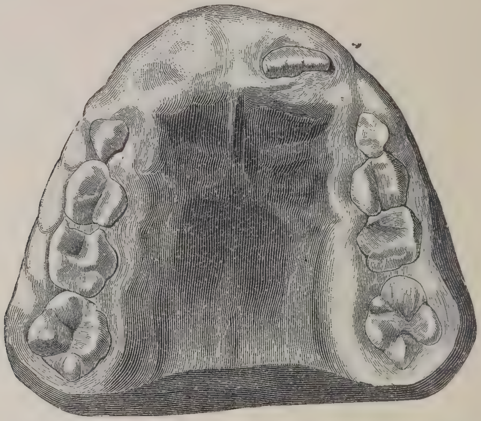

Fig. 718.[1]—T. S., aged seven years (maxilla).

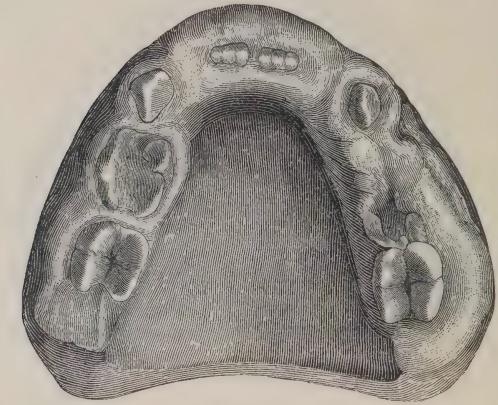

Fig. 719.—T. S., aged seven years (mandible).

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[1] *Lancet*, 1897.

cursory glance had the appearance of a cleft palate, but this was due to the fact that the hypertrophied gum on either side covered the palate almost to the median line.

A microscopical examination of the hypertrophied tissue showed that the mucous membrane covering the growth was healthy, the bulk of it being composed of delicate bundles of wavy fibrous tissue which interlaced. Between the bundles were numerous cells, in some places forming large clusters. Numerous vessels were scattered through the growth.

The case recorded by Evans already referred to is interesting as an example of the degenerative changes that may take place in the redundant tissue. The tissue removed at the first operation consisted of "translucent strands of fibrous tissue," while that removed four years later was "composed of adult fibrous tissue arranged in strands, between which was some badly staining homogeneous material denoting some myxomatous degeneration; in places were some thickened arterioles, and around these some round-celled infiltration; the overlying mucosa was slightly thickened, and beneath the thickened papillæ was some excess of round cells of inflammatory origin. The growth therefore was a fibroma undergoing early myxomatous degeneration, while the growth first removed was a pure fibroma and showed no degeneration."

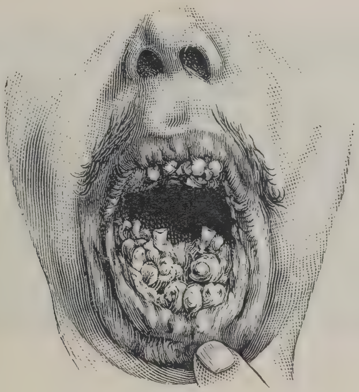

FIG. 720.

A case exhibiting another clinical variety of hypertrophy of the gums is shown in fig. 721. This patient, a man aged 43, was under the care of Montagu Hopson.[1] He subsequently developed a sarcoma in connection with the orbital plate of the maxilla. Two of his children also showed slight hypertrophy of the gums.

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[1] *Trans. Odonto. Soc.*, vol. xxxii, p. 36.

Hypertrophy of the gums is at times correlated with abnormalities of other tissues. In three cases recorded by Murray[1] which occurred in three children (two girls and a boy), the condition was associated with molluscum fibrosum and defective mentality.

In the well-known case of Julia Pastrana, hypertrophy of the alveolar process and overlying soft tissues was accompanied by excessive development of the hair. A similar condition existed in an Indian girl, Kras, aged seven years, mentioned by Parreidt.[2] The hypertrophied gums were accompanied by a well-developed growth of hair on the body.

Treatment.—Microscopical sections demonstrate that the hypertrophied gum springs from the alveolar margin. In treatment, therefore, the affected alveolar process must be removed with the excess of gum, as the trouble is likely to recur if the gum only is removed.

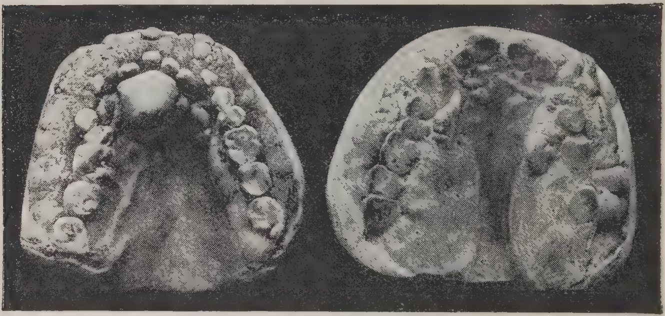

FIG. 721.[3]

(B) REACTION OF THE GUMS AND ADJACENT MUCOUS MEMBRANE TO INJURY—INFLAMMATION

A general inflammation of the mucous tissue of the mouth is called "stomatitis," but when the inflammation is limited to the gums it is usually termed "gingivitis."

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[1] *Med. Chir. Trans.*, vol. lvi.

[2] *Deutsche Monatsschrift für Zahnheilkunde*, 1886, Jahrgang iv, H. 2.

[3] From *Trans. Odonto. Soc.*

(1) GINGIVITIS

This condition may be general, or may be limited to the gum margin—" *marginal gingivitis.*"

(a) Marginal gingivitis is a common affection, and, if not treated, leads to chronic periodontitis.

Pathology.—In a mouth that is functional, the constant friction of efficient mastication and the friction of the mucous membrane of the cheeks and lips against the gum margins, assisted no doubt by the free flow of " currents of saliva," remove all debris, and keep the gingival margins in a healthy condition. Abnormal conditions, such as mouth-breathing, and functionless teeth, lead to the accumulation of food debris, &c., at the gingival margin; the material thus lodged undergoes fermentative and putrefactive changes, the soft tissue is injured, and inflammatory reaction follows. Such a condition is well marked in mouth-breathers. If the mouth of a child suffering from nasal obstruction be examined, a marginal gingivitis will be found around the anterior maxillary and mandibular teeth, while the gingival margin at the posterior part of the mouth will be found quite healthy, provided that the function of mastication is properly performed. In a mouth-breather, the natural friction of the lips against the gums is, to a great extent, in abeyance, with the result that the debris around the teeth is not removed and a condition arises which causes injury to the gingival margin. The gingivitis so often associated with many fevers arises, partly at least, from a similar cause. The fevers frequently bring about a condition which induces mouth-breathing and, a " slop " diet being necessary, the ordinary functions of the mouth are not performed, and food naturally collects at the gingival margins.

Although gingivitis is generally the direct result of lodgment of food debris, &c., it may also arise from toxic material circulating in the blood. In reference to this G. V. Black remarks that the gingival organ, in common with other glandular structures, seems to possess the function of selecting and eliminating from the blood certain poisons, as evinced in mercurial gingivitis. The elimination of the poisons or toxins leads to hyperæmia or inflammation.

It has been shown by Turner and Drew[1] that in cases of chronic gingivitis bacteria are invariably present. These authors found diphtheroids (fig. 722), streptococci and staphylococci. In one case a spore-bearing bacillus was present. In gum infections they found an entire absence of phagocytosis on the part of the tissues.

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[1] *Proc. Roy. Soc. Med.*, vol. xii (Odonto. Sec.), p. 7.

Varieties.—The inflammation is usually catarrhal in character. It *may become purulent*, while in certain patients there is a tendency to hypertrophy; large tags of tissue are formed between the interspaces of the teeth, and the gum encroaches upon the surface of the teeth which become partly hidden. This form is usually designated "*chronic hypertrophic gingivitis*" (fig. 723). The so-called "polypus of the gum" is a localized "chronic hypertrophic gingivitis."

Causes.—(i) *Local.*—Mechanical irritants, such as the accumulation of calculus and food debris at the necks of the teeth; overhanging edges of fillings and badly adjusted crowns; the injudicious use of clamps, ligatures, &c., and chemical irritants.

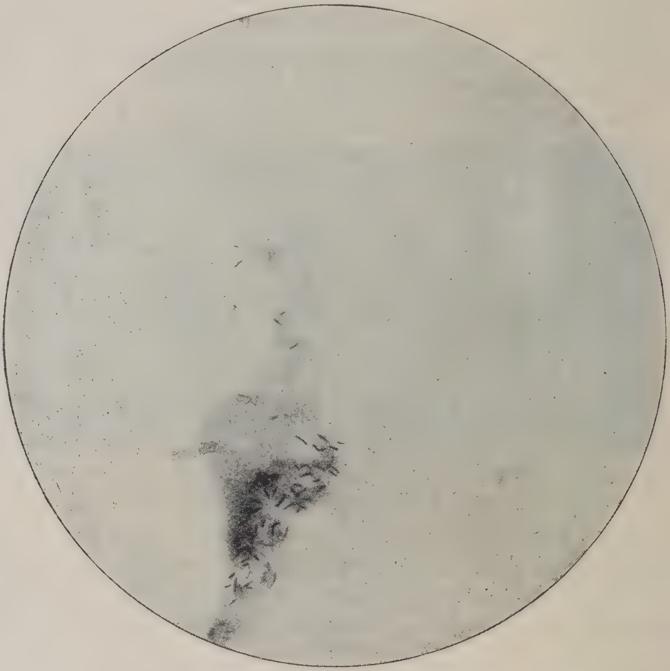

Fig. 722.—Section of gum showing diphtheroid infection.

From a paper by Turner and Drew, *Proc. Roy. Soc. Med.* (Odonto. Sec.).

(ii) *General.*—The prolonged administration of metals, such as mercury, arsenic, bismuth. Marginal gingivitis is a frequent accompaniment of certain general diseases, such as diabetes, nephritis.

Signs and Symptoms.—The free margins of the gums are red and painful and bleed freely with the lightest touch. Slight pressure will cause a thick creamy discharge to exude around the necks of the teeth.

Treatment.—The treatment of gingivitis is to remove the cause if possible. . When mouth-breathing is the cause, prompt attention must be directed to the relief of the nasal obstruction, while, if the disease is due to a general cause, general treatment must be adopted. Locally, attention must be paid to the hygiene of the mouth and special care taken to free the spaces between the teeth from all foreign matter. The pockets around the teeth may be syringed with hydrogen peroxide and an astringent mouth-wash prescribed. In marked cases, the application of powdered tannic acid to the gums twice a day will also prove a useful remedy. Where there is considerable discomfort amounting at times to pain, the application of a lotion composed of equal parts of tincture of iodine and spirits of camphor will be found beneficial. Where the inflammation is of a proliferative character, it is advisable, in addition to the above treatment, to cut off with a small pair of curved scissors the tags of gum which are present in the interstices of the teeth, and freely scarify the other parts of the gum.

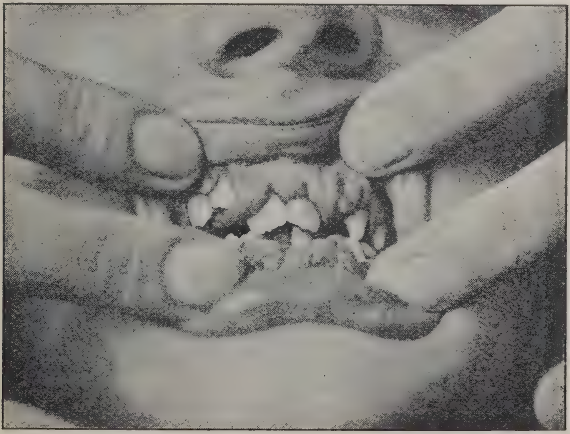

Fig. 723.

An acute attack of gingivitis may arise from direct infection, for example, the gonococcus. Under these conditions, the infection rapidly spreads to the periodontal membrane, the teeth becoming loose and bathed in pus. There is marked salivation and a rise of temperature. The treatment that answers well is thorough irrigation of the tooth sockets with hydrogen peroxide and the application of nitrate of silver, 10 gr. to the ounce, twice daily.

Lead Poisoning in Relation to the Gum Margins.—In chronic lead poisoning a blue or slate-coloured line often appears on the gums. The manner in which the line is formed is not quite clear. It is supposed that the lead brought by the blood to the gingival margin is converted into a sulphide. The line is more frequently seen on the lower gums than on the upper, and in the incisor region more than in the molar. In addition to the blue line, lead poisoning usually presents other symptoms, such as colic and wrist-drop, the latter being due to paralysis of the extensor muscles of the wrist. In rare cases the blue line is present, but no other symptoms; in such cases great care must be taken to eliminate all other possible causes. In individuals who take diachylon to produce abortion the characteristic blue line on the gum is frequently present.

The blue line must be diagnosed from (i) a delicate line of blue at the margins of the gums and teeth, but not involving the gums, which occurs in persons exposed to white lead dust for a few hours. This line is merely lead sulphide deposited upon the gums and disappears on rinsing the mouth.

(ii) A deposit under the margin of the gums, which is found in persons who clean their teeth with charcoal.

(iii) A deposit similar to (ii), occurring in miners and others exposed to carbon dust.

(iv) The line caused by copper and bismuth poisoning.

It must be noted that the blue line does not appear if the teeth are missing, and that it is most prominent when a source of irritation, as, for instance, "tartar," exists around the necks of the teeth.

Treatment consists in removing the patient from the unhealthy surroundings, when the line will generally disappear in three or four weeks, although in severe cases the line may persist for a much longer period.

(b) Chronic gingivitis is usually the result of local irritation. It is frequently seen in patients wearing artificial dentures, and is often due to want of cleanliness. The gums are slightly swollen and are red, congested and painful. In some cases the palatal rugæ become enlarged and pendulous and by overlapping add to the sepsis. A temporary abandonment of the denture and the use of astringent mouth-washes is sufficient to effect a cure. It may be necessary to cut away redundant tissue. The general condition of the patient will need treatment.

Artificial dentures in certain subjects, more especially those of a gouty or rheumatic diathesis, produce a peculiar tenderness of the gums, accompanied by an itching sensation, the patients stating that they can only get relief by removal of the dentures. Local applications are of little use, and the removal of the denture, except, of course, at meals, seems to be the only means of obtaining relief.

A rare form of chronic inflammation of the gums has been described by Arkovy[1] under the name of "*gingivitis nudata.*" The disease usually has its seat in the roof of the mouth and spreads until it involves the interdental papillæ, or it may be limited to the latter. It appears at all stages of life and may continue for one or two years. With the naked eye it is difficult to locate the junction of the affected with the non-affected part, as the edges are not pronounced and the colour of the gums is unaltered. *The pathology of the condition* is an entire absence of the epithelial covering of the submucous tissue, leaving the papillæ exposed.

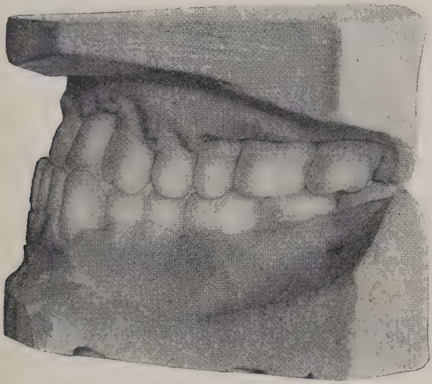

Fig. 724.[2]

The etiology is obscure: occasionally it may be traced to scalding. Dentures with rough surfaces, or which do not fit accurately, may contribute to the production of the disease. The symptoms are a feeling of "continual burning with sensitiveness of touch, especially during meal-times."

Treatment should aim at restoring a layer of epithelium over the denuded sub-mucous tissue. All irritants, whether in the form of foods or otherwise, should be avoided. The foods taken must be of a mucilaginous and slippery character, and all medicaments must be administered in a similar condition.

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[1] *Dental Cosmos*, October, 1893.

[2] From *Dental Cosmos.*

Ulcerative Gingivitis—Vincent's Angina.—This condition is seldom found in mouths where the gingivæ are normal. The ulceration usually starts around badly fitting crowns, in the deep pocket posterior to the mandibular third molar, and in mouth-breathers around the necks of the mandibular incisors, but it may commence in any position where there is periodontal disease—in other words, in pre-existing stagnation areas. Within from twenty-four to forty-eight hours the infection spreads rapidly along the gingival margin, involving both jaws, and often extends backwards to the pillars of the fauces, to the hard palate, and the floor of the mouth. The gums bleed readily and present a ragged margin of necrotic tissue; the periodontal membrane is rapidly involved, and the margin of the bone becomes exposed (fig. 724). With the gum condition are usually associated lesions of the mucous surfaces of the fauces, tonsils, soft palate and pharynx, which become covered with patches of exudation forming a yellowish to greenish-yellow membrane, and these may remain superficial or tend to spread into the deep layers of the tissues. The breath has a most offensive odour, and pus and blood well up around the teeth. If left untreated, the teeth rapidly loosen and are lost, and the adjacent tissues are deeply ulcerated and the lymphatic glands enlarged. The local condition is attended by a rise in temperature varying from 100° to 103° F., which usually falls to normal about the fourth or fifth day.

Taylor and McKinstry[1] are of the opinion that the primary lesion is in the gums, and that the throat and pharynx are infected from the gums.

An absence from the diet of anti-scorbutic vitamines has been suggested as a predisposing cause of this form of gingivitis. Support is given to this view by an examination made by D. Clewer[2] of fifty cases. The results were as follows:—

Cases receiving no fresh vegetable ration			... ...	82	per cent.
,,	,,	vegetable ration once a week	...	4	,,
,,	,,	,, ,, twice ,,	...	6	,,
,,	,,	,, ,, thrice ,,	...	6	,,
,,	,,	,, ,, more than thrice a week		2	,,

There is every reason to believe that the disease is communicable. It was very prevalent among the troops during the Great War.

The symptoms and general course of the disease are similar to those characterizing the condition usually known as Vincent's angina; "indeed, it is probable that they are one and the same affection, the main focus of the disease lying in the gingivæ." Two varieties of Vincent's angina are recognized: a mild or diphtheroid type, in which the process is limited in extent of surface and does not penetrate to any depth; and a severe or ulcero-membranous type, in which the process extends rapidly over the surface and involves the mucous membrane deeply.

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[1] *Brit. Dent. Journ.*, vol. xl, p. 749.

[2] *Brit. Med. Journ.*, March 31, 1917.

Bacteriological examination shows that, in addition to pyogenic cocci, a characteristic bacillus (*B. fusiformis*) is present in the exudation frequently associated with a spirillum. In the mild type, the bacillus predominates; in the severe type, the spirillum is "much more frequent and may even be present in greater numbers than the bacillus." The bacillus described by Vincent is called the "fusiform bacillus."

R. Tunnicliff[1] in an examination of freshly excised tonsils affected with Vincent's angina found enormous numbers of *B. fusiformis* and spirochætes in the zone separating the external necrotic epithelium and the living tissue. The organisms were invading the normal tissue, the spirochætes being more abundant and in advance of the *B. fusiformis*. "In the line of advancing necrosis there appeared to be no association with cocci and bacilli, which were abundantly present in the exudate on the surface of the tonsils."

Treatment consists in thorough irrigation of the pockets around the teeth, and also of the affected mucous membrane, with hydrogen peroxide, followed by the application of strong *tincture of iodine*. The acute symptoms rapidly improve under this course of treatment, but a chronic condition often remains which requires careful hygienic treatment on the part of the patient. Teeth which are obviously the source of chronic sepsis should be removed, and, in cases where the stomatitis spreads from misplaced third molars, these teeth should be removed.[2]

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[1] *Journ. Infect. Diseases*, vol. xxv, p. 132.

[2] In connection with this question, the following papers will be found worthy of perusal: "On Vincent's Angina." H. W. Bruce, *Lancet*, July 16, 1904, p. 135. "Cases of stomatitis and tonsillitis in which Vincent's spirochæte and bacillus were present." W. H. Harwood-Yarred and P. N. Panton, *Lancet*, February, 1906, p. 438. "The Relation of Periodontal Gingivitis to Vincent's Angina," F. E. Taylor and W. H. McKinstry, *Brit. Med. Journ.*, March 31, 1917. "Ulcero-membranous Stomatitis and Gingivitis among Troops on Active Service," F. B. Bowman, *Brit. Med. Journ.*, March 11, 1916. "Ulcerative Gingivo-stomatitis due to Vincent's Bacteria," H. S. Vaughan, *Dental Cosmos*, June, 1912.

The local application of ipecacuanha and arsenic is strongly recommended by some authors.[1]

It is most important that mouth-breathing, if present, should be corrected; as long as it is present the condition is extremely difficult to control.

In intractable cases the local application of salvarsan has been recommended, the drug being applied to the pocket on a swab moistened with glycerine.

(c) Polypus of the Gum.—Polypus of the gum is the name given to a local hypertrophy of that tissue caused by irritation.

Causes.—This condition is generally found in connection with the ragged edge of a cavity or root, or may be brought about by the presence of calculus, or even irritation from a clasp or other portion of an artificial denture.

Appearances.—In character and microscopical appearance a polypus resembles the gum tissue. The growth really starts as a simple hypertrophy of the gum; this increases and becomes pedunculated, and, if the cause is not removed, may become so enlarged as to simulate a fibrous tumour.

A polypus of the gum may, as it grows, encroach upon the cavity and eventually completely fill it. Should the hypertrophied tissue come in contact with the opposing teeth, ulceration will ensue and give rise to considerable pain.

Diagnosis.—When the polypus occupies the cavity, care must be taken to diagnose it from a polypus of the pulp. The diagnosis is not difficult, as in one case the pedicle of the growth will be in connection with the pulp chamber, while in the other it can be traced to the gum between the teeth. The polypus of the pulp is not painful to the touch, whereas polypus of the gum is extremely painful to pressure.

The treatment consists in removing the source of irritation, but, in addition, it is generally advisable to snip off the growth, or, if the growth is in connection with a cavity, it is better to remove the growth with some potassa cum calce, or with the actual or electrical cautery. The cervical margin of the cavity must be carefully trimmed, so as to avoid any overlapping edges which might assist the accumulation of food debris, &c., and so provide a source of irritation.

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[1] ℞ Vin. ipecacuanhæ... ... ℥ss
Glycerini ... ... ʒj
Liq. arsenicalis ... ... ad ℥j

(2) STOMATITIS

(a) Catarrhal Stomatitis.—This form is generally associated with inflammation of the throat or nose, and probably arises from the same cause as catarrh of those parts. It is frequently seen in the course of the exanthematous fevers and gastro-intestinal disturbances. The excessive use of tobacco, or too hot or too highly seasoned foods, may be cited as causes.

Signs and Symptoms.—The serum from the congested mucous membrane filters into the sub-epithelial space. There is an increased production of surface epithelium and also of mucus. The mucus continues to accumulate and, with the serum, forms the peculiar sticky discharge seen in these cases. In more severe cases the epithelium may be detached in large masses, the sub-mucous tissue becomes greatly infiltrated with leucocytes and the whole mucosa swollen, giving rise to a purulent or muco-purulent condition. The margins of the gums become acutely inflamed and painful to the slightest touch. In the early stages the gums are dry, but this is soon followed by an excessive secretion. The portion of gum attached to the margin of the alveolar process is pale, while the reflection of the gum from this point on to the cheek will show the vessels to be congested. The gums appear whitish and mottled, and pus is generally seen welling up from the sulci around the teeth.

The mottled appearance of the gums is due to the fact that in inflammation the epithelium proliferates and appears whitish, but through the friction which occurs between the gums and the cheeks the epithelium covering the papillæ of the gums is rubbed off and leaves reddish patches here and there. The breath is fœtid, the patient has a sensation of heat and pain and the taste is impaired. The tongue is furred, there is a loss of appetite, derangement of the bowels, and a feeling of malaise.

Treatment.—The cause should, if possible, be removed, antiseptic and astringent mouth-washes should be used and the general condition of the patient treated by appropriate remedies.

(b) Follicular Stomatitis.—This inflammation is similar to an ordinary herpetic eruption. A cluster of vesicles first appears; the vesicles break down, coalesce and form a small circular and well-defined ulcer. This ulcer is surrounded by a zone of redness, and is extremely painful. The ulcers are said to occur more frequently near the frænum of the lip, on the under surface of the tongue, and in the sulcus between the gums and the lip. The little round punched-out ulcers met with in the cheeks are probably a variety of this form. Follicular stomatitis occurs in adults less frequently than in children. It is often associated with some gastro-intestinal disturbance.

The *treatment* consists in the application of an astringent solution, and, in intractable cases, the ulcers may be touched with a crystal of sulphate of copper or nitrate of silver. The general condition of the patient must also be treated.

(c) Aphthous Stomatitis.—This form rarely occurs in adults. It is characterized by the formation of fibrous deposits on and under the epithelium, and is considered by some authors to be contagious. It is frequently met with in rachitic and weakly children and is most common during the periods of dentition. In adults it occurs in those debilitated by illness, or may be associated with general inflammatory conditions. In women, it occurs during menstruation, pregnancy, and during the puerperal period.

Bacteriology.—Out of ten cases of aphthous stomatitis examined by K. W. Goadby, there was present in six of them a streptococcus which had the characters of the *Streptococcus fæcalis*, and not of the ordinary *Streptococcus brevis* of the mouth.

Signs and Symptoms.—Small yellowish-white patches, slightly elevated and extremely sensitive, are present on the mucous membrane. The patches are surrounded by a zone of inflammation. They have a tendency to spread and coalesce, forming large patches. When not associated with any active general disease, constitutional symptoms may be present, namely, slight elevation of temperature, thirst and loss of appetite.

Treatment.—Locally, a mouth-wash of chlorate of potash should be used, and the mouth thoroughly cleansed after each meal. If the aphthæ persist, they may be treated with nitrate of silver. The constitutional condition also requires attention.

In cattle *aphthous stomatitis appears in an epidemic form* and is commonly known as "*foot-and-mouth disease.*" It is communicable to man. In man it is an eruptive fever running a fixed and definite course, usually in eight to ten days, and is characterized by a vesicular eruption in the mouth, on the lips, gums and tongue, as well as on the hands and feet. In the early stages of the disease there is a headache and loss of appetite, with a quickly rising fever. Pustules appear in the mucous membranes of the mouth, more frequently on the lips and the tongue than on the hard palate and the throat. After a few days the pustules burst, leaving eroded spaces with greyish-yellow surface, which during the second week commence to heal. In the acute stage, the patient suffers from a sensation of heat and burning in the mouth, and the cervical and salivary glands swell, producing severe dysphagia.

(d) Ulcerative Stomatitis.—This condition is most frequently met with in children. It may prevail in an epidemic form in institutions where insanitary conditions exist. Want of cleanliness, faulty hygienic surroundings, and general ill-health favour the development of the disease.

The inflammation commences at the free margin of the gums, and is said to be more frequent in the maxilla. In the early stages the gums are swollen and congested, the congested veins leading to the part being distinctly visible. The ulceration, commencing at the free margin, gradually spreads, denuding in its course the alveolar process, and leading to necrosis of the teeth. The adjacent mucous surface of the cheek usually becomes attacked from contact, and, if the case is left alone, the ulceration may extend, leading to extensive necrosis, sloughing, and, ultimately, death of the patient. In well-developed cases, an ulcer with sharp irregular edges is seen, the margin displaying a bluish ring, the ulcer being covered with a greyish or yellowish slough, the neighbouring lymphatic glands being enlarged.

Bacteriology.—In this disease, the *Bacillus fusiformis* and *Spirochæta dentium* are always present in great numbers; and observers who have examined such cases have generally come to the conclusion that the fusiform bacillus and the spirochæte are the causative organisms.

By epidemiologists the disease is often thought to be related to the foot-and-mouth disease of cattle (see p. 582), and in this disease no definite micro-organism has been isolated; but whatever the organism may be, it is apparently somewhat smaller than any organism we are acquainted with as yet, as the living virus will readily pass through the pores of a Pasteur and Chamberland filter.

Guezette[1] considers that ulcerative stomatitis is closely related to noma. The most constant feature in three cases he examined was the presence of a spirillum and a bacillus. The discharge from a case he injected into his own lip, and found that the spirillum speedily disappeared whilst the associated streptococcus flourished freely.

In three cases of ulcerative stomatitis which Goadby examined he found, in addition to the spirochæte and *Bacillus fusiformis*, the *Saccharomyces albicans* present in large numbers, both on the films direct and upon cultivation. The organism takes some little time to develop, and may easily be missed. It is quite possible that this organism may be only a concomitant to the inflammatory condition, but it is not common in ulcerative lesions of the mouth; whereas the *Bacillus fusiformis* and the spirillum occur whenever any diseased condition of an inflammatory nature is present in the mouth.

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[1] *Archiv. de la Sci. Méd.*, vol. xxiii, No. 1.

Signs and Symptoms.—In the early stages there is little pain, and the disease may be far advanced before it is detected. The odour of the breath is usually the first symptom noticed. Constitutional symptoms are marked in severe cases, and death sometimes results.

Treatment.—Treatment consists in administering internally chlorate of potash, a drug which seems to be a specific for this disease. Children should be given 5 to 10 gr. according to age, adults 15 to 20 gr. It is well to give at the same time some iron or such-like tonic in the following form:—

℞	Liquoris ferri perchloridi	♏ii
	Potassæ chloratis	gr. v to x
	Aquam aurantii ... ... ad	ʒi

Misce. Mitte ℥ii.
(One teaspoonful to be taken three times a day after meals.)

A mild purgative should be given, and an endeavour made to improve the surroundings of the patient, should these be at fault. Plenty of exercise in the fresh air should be recommended.

Locally, all unhealthy teeth should be removed, and the ulcer should be painted with a strong solution of nitrate of silver, the mouth being kept clean by frequent irrigation with hydrogen peroxide. Should the cheek be involved as well as the gums, a strip of lint moistened with carbolized oil should be placed between the two surfaces. A gargle of chlorate of potash should be prescribed,[1] and its frequent use recommended. Under this treatment most cases speedily improve.

(e) Gangrenous Stomatitis; Noma; Cancrum Oris.—This very serious disease is a rapidly spreading gangrenous inflammation which usually attacks the cheeks, and occurs in children from 2 to 6 years old. The disease may, however, occur in adults.[2] It is more common in girls than in boys. It is frequently seen in those just recovering from one of the exanthematous fevers. Unhygienic

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[1]

℞	Potassæ chloratis	℥i
	Acidi hydrochlor. dil.	℥ss
	Aquam ... ... ad	Oi

Misce. To be used as a gargle.

[2] See *Lancet*, December 21, 1921, p. 1730.

surroundings and weakening of the system by long-continued administration of mercury also act as predisposing causes. The disease may start either in the substance of the cheek, or in the mucous membrane, the latter being the more usual situation. The cheek becomes hard, brawny, and very swollen, a dark red colour showing in the centre, the surrounding parts being œdematous. At this stage, if the mouth be examined, an ulcer will be seen on the mucous surface of the cheek corresponding to the dark spot on the cheek. The ulceration, or rather sloughing, leads to perforation of the cheek, and, if the disease still pursues its course, the soft parts rapidly become gangrenous. The child becomes exhausted, delirious, and eventually dies of exhaustion, blood poisoning, or some septic affection of the lungs.

The facts that the whole cheek becomes gangrenous, and that the disease is not amenable to the action of chlorate of potash, help to distinguish it from ulcerative stomatitis, but most authors think that the difference between cancrum oris and ulcerative stomatitis is only one of degree. The disease is said to be caused by thrombosis of the capillaries, induced by the presence of a specific micro-organism, and to be similar to the gangrenous inflammation known as noma, which occurs upon the female genitals.

The disease in rare instances may commence at the gingival margin. A case in point is recorded by C. Lockyer.[1] The patient, a youth aged 18, removed three roots of a tooth by means of a wooden penholder sharpened and used as an elevator. Four days subsequently the face began to swell, gangrene ensued and spread rapidly over the palate and the alveolar process, the patient eventually succumbing to general septic infection (fig. 725).

The *prognosis* of cancrum oris is bad. The *treatment* consists in carefully drying the soft parts, removing all gangrenous portions, and cauterizing the remaining surface with nitric acid, or the actual cautery. The general treatment should consist in supporting the patient's strength with a plentiful supply of beef-tea and other nutritious remedies. It has been suggested that free excision of the gangrenous surfaces would be an effective treatment, and in cases recorded it has proved beneficial. Corrosive sublimate locally applied has been used; it has proved successful in three cases recorded by Kingsford.[2] Disinfectant mouth-washes must be prescribed, and the raw surfaces carefully dressed with antiseptics.

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[1] "A Case of Gangrenous Stomatitis," *Brit. Dent. Journ.*, vol. xxix, p. 605.

[2] *Lancet*, May 4, 1889.

The disease may spread until the whole side of the face disappears, the cavity extending from the nose to the ear, and from the lips to the upper eyelid.

(f) Parasitic Stomatitis.

(i) **Thrush.**—Thrush is a parasitic inflammation of the mucous membrane of the mouth. It is common in infants, but may occur in adults, and, in the latter, is generally associated either with some of the acute specific fevers, or with chronic wasting diseases, such as phthisis. When associated with phthisis it generally proves fatal. The fungus develops in the upper layers of the mucosa, the filaments forming a dense network among the epithelial cells. In this manner the mucous membrane becomes covered with numerous white spots, which are firmly adherent, and, when removed, a deep red colour is revealed. These spots appear mostly near the angles of the mouth and on the tongue, but may occur elsewhere in the oral cavity, the affection spreading at times to

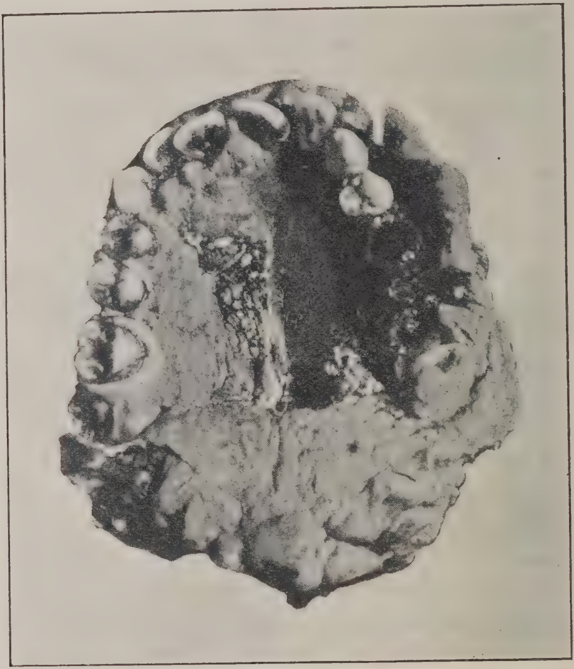

Fig. 725.—A case of gangrenous stomatitis. Museum of Charing Cross Hospital.

the pharynx and œsophagus. The spots are about the size of a pin's head, are circular in form, and they gradually coalesce and form larger patches, giving rise to the appearance of a false membrane with a slightly yellowish aspect. These patches come away of their own accord, leaving a reddish surface beneath. The patches are found to consist of epithelium and fat, together with sporules of the vegetable parasite which causes the disease.

It is usually acknowledged that thrush is due to the *Saccharomyces albicans.* Castellani,[1] however, states that in the tropics, at any rate, thrush is not caused by one fungus only, but by a number of different fungi, and that in reality the term thrush does not cover one affection, but a group of clinically similar conditions due to various organisms. He describes eleven types of Monilia found in thrush. Fungi of the genus Monilia are most common, and to this genus belong *Oïdium albicans* or *Monilia albicans.* Fungi of the genera Hemispora, Willia, Endomyces and Saccharomyces are also met with.

When children are affected by thrush they are generally found to be out of health, the bowels relaxed, the evacuations green and sour. The motions are generally acrid, and irritate the margins of the anus, giving rise to an erythematous blush over the buttock, the appearance of the edges of the anus being similar to that seen in the mouth. Sucking and deglutition are impaired by the condition of the mouth, and the child will usually be in a state of drowsiness and torpor. Many cases of thrush in infants are distinctly traceable to the use of dirty feeding-bottles.

The *treatment* of thrush may be divided into local and general. The *local* treatment consists in carefully wiping the mouth with soft lint after each meal, care being taken to burn the lint after use. The exposed surfaces thus left are touched with a solution of 3 dr. of borax to 1 oz. of water. In severer cases, it will be advisable to use nitrate of silver, 5 gr. to the ounce, or dilute carbolic acid in glycerine. It is needless to say that attention should be given to the condition of the feeding-bottle. The *general* treatment should consist in careful attention to the diet, with the administration of a mild aperient.

(ii) **Due to the Aspergillus nigrescens.**—An inflammatory condition due to the presence of the *Aspergillus nigrescens* has been reported.[2]

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[1] "The Higher Fungi in Relation to Human Pathology," *Lancet*, April 24, 1920, p. 895.

[2] *Medical Record,* October, 1896 (*Dental Digest,* p. 641, 1896).

The following is a brief account of the case: "A small ulcer first appeared on the middle line of the roof of the mouth, about half-way between the incisors and the soft palate. The patch increased slowly in size, and others formed in the neighbourhood, the condition appearing like a lumpy patch extending from just behind the incisors to within one-fourth of an inch of the soft palate. Cup-shaped elevations on the soft palate appeared on either side of the middle line. A firmly attached membrane, giving rise to hæmorrhage when forcibly removed, covered the areas. The colour of the recent deposit suggested the sulphur-coloured scutula of favus; where it had remained undisturbed it was darker. With low power the growth was recognized under the microscope as a fungus differing from the achorion. The mycelium network was composed of delicate fibres, bearing perpendicular fructifying hyphæ. Scattered over the field were a number of fruit receptacles and a few spores. The manner of fructifying showed that the fungus did not belong to the oïdium, but to the ascomycetous genus. Cultures showed the *Aspergillus nigrescens.* Upon applying 25 per cent. ethereal solution of pyrozone, improvement was immediately noticed. The pseudo-membrane disappeared and new patches ceased forming. After seven weeks' treatment the patient was well."

"The spores were supposed to have been implanted in the mouth through the medium of cheese, strong and mouldy varieties of which the patient was very fond of eating."

(g) Metallic Stomatitis.—Prolonged use of mercury, bismuth and other metals is likely to lead to gingivitis which rapidly spreads to contiguous parts. The ptyalism, so often seen in cases of mercurial stomatitis, is due to the spread of inflammation to the salivary glands. The early symptoms are soreness and discomfort in the mouth, accompanied by a metallic taste and fœtid breath. The gums become inflamed, and present a deeply congested appearance at the free edges; the portion attached to the margin of the alveolar process remains whitish, and the portion beneath presents the whitish mottled appearance referred to previously. The teeth become loose, sloughing and ulceration occur near the margin of the gum; the slough separates and the teeth fall out. The inflammation spreads rapidly to the cheeks, tongue, floor of the mouth, and to the salivary glands, leading to a profuse flow of saliva. There is much pain in swallowing, speaking, and on moving the jaws. In severe cases, if not quickly treated, extensive sloughing and necrosis may supervene.

With regard to the pathogenesis of mercurial stomatitis, Alonkvist[1] considered that the metal circulating in the blood was deposited in the vessels of the gum margin in the form of the sulphide by the action of hydrogen sulphide formed from proteid matter around the gum margins; the mercuric sulphide acting as an irritant and so rendering the tissues susceptible to infection. J. E. McDonagh maintains there is nothing specific in mercurial stomatitis. He states[2] that "it is merely a sign of metallic intoxication and can follow equally well the over-use of other metals, such as aluminium, antimony, arsenic, bismuth, copper, manganese, thorium, &c. A metal produces intoxication when it undergoes oxidation, and this is only when it has caused such a dispersion of the protein particles in the serum as to render the same acid in character. Stomatitis is one of the symptoms of this increased acidness. Non-metals, belonging to the sulphur group of elements, which includes sulphur, selenium and tellurium, cause condensation of the protein particles, which has the effect of increasing their baseness. Furthermore, these non-metals prevent metals from becoming oxidized; instead, they manufacture the medium upon which metals work to increase the oxidizing action of the protein particles. It thus comes about, that metals are antidotes in non-metallic poisoning and non-metals in metallic poisoning. Hence the introduction of intramine (di-ortho-di-amino-thio-benzene) for use in mercurial and arsenical intoxication. Owing to the fact that intramine cannot be readily injected intravenously and that it causes pain when injected intravenously, I have replaced it by contramine (di-ethyl-ammonium di-ethyl-di-thio-carbamate). Contramine is readily soluble in water, easy to inject, painless, and very much more efficacious than intramine. Contramine should be used in 0·25-0·5 grm. doses."

D. Clewer[3] refers to eighty-eight cases of mercurial stomatitis treated with intramine. Marked relief was obtained in twenty-four hours in forty-three cases, and in the course of a few days in forty-four cases.

(3) LEUCOPLAKIA

Leucoplakia of the cheeks and the palate is of frequent occurrence in syphilitics and those addicted to heavy smoking. It is more usually seen in the muco-periosteum covering the back of the hard palate, and in marked cases presents the appearance of

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[1] See "Mercurial Stomatitis: Present Status of the Question," Raymond Lulle, *Le Progrès Dentaire,* September, 1907.

[2] Private Communication.

[3] *Brit. Dent. Journ.,* 1921, p. 769.

"ichthyosis." At times the condition may be limited, and give rise to a definite swelling of a white, cauliflower-like growth. H. P. Pickerill[1] has recorded a case of this character. On the tissue being removed and examined microscopically, the growth was found to consist of epithelial cells, which, instead of becoming squamous and then desquamating, had become swollen and hardened and remained *in situ* (fig. 726). The sub-mucous tissue was normal. This author considers the condition similar to the "pre-cancerous" conditions of the tongue described by H. T. Butlin.[2]

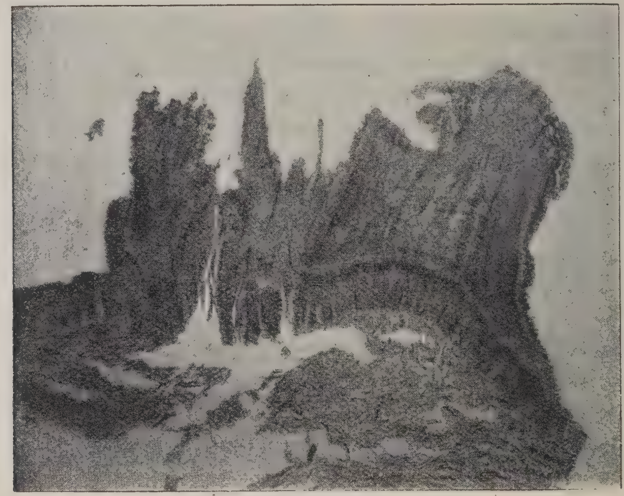

FIG. 726.[3]

(C) PEMPHIGUS

The eruption of pemphigus may occur in the mouth, and one rare form, *pemphigus vegetans*, may remain localized to the mouth and adjacent cavities. The following case[4] will illustrate this condition.

The patient was a man, aged 72, who complained of soreness in his mouth and inability to take solid food. On the roof of the mouth and on the epiglottis were patches of false membrane of considerable thickness, which, when removed, left a raw, bleeding surface. Some decayed teeth were extracted and antiseptics used, but blebs formed on the roof of the mouth, the soft palate, the cheeks, under the tongue, and on the posterior wall of the pharynx. Bacteriological examination of the membranes gave negative results. There was neither fœtor nor salivation. Whenever the patient attempted to masticate solid food a fresh crop of blebs appeared.

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[1] "A Note on a Case of Ichthyosis Gingivæ," *Brit. Med. Journ.*, vol. xxx, p. 733.

[2] *Brit. Med. Journ.*, January 9, 1909.

[3] From *Brit. Dent. Journ.*

[4] Dr. Lewis Maller, *New York Med. Journ.*, July 3, 1898.

(D) PURPURA

In the severe form of purpura known as "purpura hæmorrhagica" the gums and mucous membranes may be the seat of the hæmorrhage. A similar condition is occasionally seen in patients who are the subjects of hæmophilia, spontaneous hæmorrhage occurring at the margin of the gums.

The treatment of purpura belongs to the domain of general medicine. The hæmorrhage from the gums can be treated by the use of astringents such as tannic acid, the application being combined with a certain amount of pressure.

(E) SCURVY

When the gums are affected by scurvy they become dark, turgid, spongy, and so swollen as to hide a considerable portion of the surfaces of the teeth. At first the gums bleed readily; this is followed later on by a constant oozing. Ulceration and sloughing of the edges of the gums take place, leading to loosening and loss of the teeth and necrosis of portions of the jaws. In scurvy, the mucous membranes are anæmic, and there will be a strong contrast between the reddened gum and the pale mucous membrane covering the lips. Petechiæ or patches of hæmorrhage may occur on the hard and soft palate. W. H. Willcox states[1] that "a characteristic dark crimson or purplish area of discoloration commonly extends from the inner aspect of the molar teeth upwards towards the palate." The local symptoms are always associated with marked general symptoms indicative of the disease. In infantile scurvy changes in the gums are absent if no teeth have erupted, and in scorbutic adults the gums show no change if the patients are edentulous.

The treatment of scurvy cannot be dealt with here. Suffice it to say that the mouth must be kept quite clean by the constant use of antiseptic lotions.

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[1] "Diseases due to Dietetic Deficiencies," *Proc. Roy. Soc. Med.*, vol. xiii, No. 3 (Section of Therapeutics), p. 78.

(F) LEUKÆMIA

In many cases of lymphatic leukæmia a prominent feature is a severe form of stomatitis with sloughing and gangrene of the gums, but without any implication of the subjacent periosteum or bone.

(G) PERFORATING ULCERS OF THE MOUTH

Such ulcers, which are due to trophic changes, are occasionally seen in patients who are the subjects of *tabes dorsalis.*

As to the explanation of the lesion, there are two views: (1) that of Galippe, that it is the result of periodontal disease aggravated by tabes; and (2) that of Baudet, that it is an atrophic tabetic lesion, due to the fifth nerve being affected, which begins by loss of the teeth and atrophy of the jaws, and sometimes terminates by ulceration and perforation into the maxillary sinus.

(H) TUBERCLE

Tuberculosis of the mucous membrane of the mouth is a rare condition and seldom arises as a primary lesion.

The changes in the mucous membrane are similar to those seen when the disease is located in the skin. The tubercular nodules are present as minute white points set in a red thickened membrane. Ulceration occurs at an early stage owing to "the constant maceration of the newly-formed abnormal tissues by the fluids of the mouth." The ulcerating patch has well-defined borders. "The most characteristic feature of tubercular ulcers of the mucous membrane of the mouth is the presence of minute tubercular nodules in the margins and underneath the layer of granulations."

(I) SYPHILITIC INFLAMMATION AND ULCERATION

Syphilis may affect the gums and the oral mucous membrane in any of its stages.

The primary lesion may occur on the gums, tongue, or other parts, and often assumes an unusual appearance. Ulcers of peculiar appearance and uncertain origin should always be regarded with suspicion, and the possibility that they are of syphilitic origin should be carefully inquired into.

Secondary lesions may appear in the form of mucous patches in almost any part of the mouth; the favourite situations are the inner surfaces of the cheeks, the edges of the tongue and the angles of the mouth. In weak and debilitated patients, the mucous patch may break down, leaving an ulcer with a sinuous outline. The ulceration may extend and lead to extensive destruction of the tissue, followed, on healing, by adhesion of contiguous parts and extensive contraction.

In the tertiary stages the ulcerations are generally of a deep, excavated character, and are preceded by gummata, which, undergoing degeneration, produce the ulceration.

(J) ANEURISM

A case is recorded by J. H. Edward[1] in which the anterior palatine artery entered the mouth through an aperture in the centre of the suture between the palatine bones. The pressure of a denture at this part led to an aneurismal dilation of the vessel.

The various tumours arising in connection with the gums are described in Chapter XXXII.

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[1] *Journ. Brit. Dent. Assoc.*, vol. xvi, p. 272.

CHAPTER XIX

Saliva

Physical Characters and Composition—Conditions of Normal Secretion—Adaptation of Salivary Secretion to Diet—Bactericidal Properties—Relation of the Saliva to Caries of the Teeth—Salivary Calculi—Degeneration of the Salivary Glands—Infection of Salivary Glands

(A) PHYSICAL CHARACTERS AND COMPOSITION

Mixed saliva consists of the secretions of the parotid, the submaxillary and the sublingual salivary glands together with the secretions of the buccal mucous glands. When collected from the mouth the fluid contains epithelial cells, salivary corpuscles, micro-organisms and other debris.

Mixed saliva freshly collected is a transparent, slightly opalescent and viscid fluid, but after standing for a short time it becomes slightly turbid. The turbidity is caused by the precipitation of calcium carbonate which, being held in solution by carbonic acid, is deposited as the acid escapes. The specific gravity of mixed saliva is 1002 to 1006. In health the reaction is alkaline. In man about 0·5 per cent. of the contents on an average consists of solids. According to Halliburton, the solid constituents which are found dissolved in mixed saliva may be classified as follows:—

Organic

(*a*) Mucin: may be precipitated by acetic acid.
(*b*) Ptyalin: an amylolytic ferment.
(*c*) Proteid: of the nature of a globulin.
(*d*) Potassium sulphocyanate.

Inorganic

(*e*) Sodium chloride: the salt in greatest abundance.

(*f*) Other salts: sodium carbonate, calcium phosphate and carbonate, magnesium phosphate, potassium chloride.

The peculiar character of the secretion of each of the glands is shown below:—

(*a*) *Parotid.* Clear and watery. On standing, a deposit appears, consisting principally of carbonate of lime. The total amount of solids is 0·3 to 0·5 per cent. There is no mucin.

(*b*) *Submaxillary.* Thick and viscid. Contains mucin and, on standing, deposits chloride of potassium and sodium. Solids 2·1 to 2·5 per cent., consisting of mucin and ptyalin, with potassium and sodium chlorides, and calcium and magnesium phosphates and carbonates.

(*c*) *Sublingual.* The richest in solids—about 2·75 per cent.—and the principal source of ptyalin. The salt in greatest abundance is phosphate of lime.

(*d*) *Mucous.* According to Bidder and Schmidt, the secretion contains water and mucin and inorganic salts, of which the chief is sodium phosphate.

(B) CONDITIONS OF NORMAL SECRETION

The secretion of saliva is normally due to the reflex action called forth by various stimuli applied to different parts of the mouth. The afferent impulses are conveyed to the nerve centre by the lingual and glosso-pharyngeal nerves in the tongue and the sensory branches of the fifth nerve distributed to the mucous covering of the buccal cavity. The efferent impulses are represented by the chorda tympani in the submaxillary and sublingual glands, the auriculo-temporal nerve in the parotid gland, and by fibres of sympathetic nerves supplied to each gland. A flow of saliva can also be induced by means of stimuli conveyed viâ the optic, olfactory and auditory nerves.

Excellent research work on the secretion of saliva has been carried out by H. P. Pickerill and the following particulars are taken from the various papers which he has published.

Research work on salivary secretions in the past has invariably been carried out on animals, and mainly by electrical stimulus of the efferent nerves. Pickerill questions the efficiency of these methods, firstly, because a natural stimulus is not employed, and secondly, because an electrical stimulus affects all the nerve fibres at one and the same time. There is reason to believe that two if not more different sets of nerve fibres exist, each of which specifically affects the salivary secretion and is normally excited by separate reflex stimuli in the mouth, and a stimulus which cannot be applied separately to each set of fibres would obviously give unsatisfactory results. He recommends that in experimental investigation the saliva should be obtained (1) from the human subject;

(2) from a subject in whom there is apparently an average salivary activity; and (3) by natural or ordinary methods of stimulation, or, if in the "resting" stage, under known and constant conditions.

For the purpose of obtaining saliva the following plan was adopted:—

(i) A small canula made of thin German silver was inserted into the parotid duct. (By bending the canula slightly it can be held by the duct.)

(ii) A "segregator" was constructed to obtain the sublingual and submaxillary secretions. This appliance was somewhat akin to a vulcanite denture with a hollow chamber made of soft vulcanized rubber attached on one side (see fig. 727). This chamber was open at the bottom, the margins being exactly applied to the floor of the mouth. A metal tube 3 mm. in diameter was inserted into the chamber, the orifice being as nearly as possible over the opening of the ducts. The metal tube was bent so as to pass into the buccal sulcus and a rubber tube was attached to transfer the secretion to a receptacle. Every endeavour was made to carry out the experiments under identical conditions and, for comparison, experiments on the saliva secreted during mastication and the "resting" saliva were undertaken. (By "resting" saliva is meant the saliva present in the mouth some hours after eating.) The total flow of saliva per minute and the *total amount* of solids *per minute* present in the mouth were estimated.

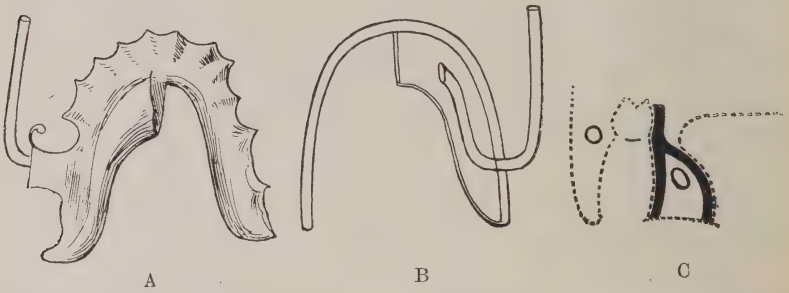

FIG. 727.—A, upper surface of segregator; B, under surface—diagrammatic; C, diagrammatic section of segregator in position.

From Pickerill's "Dental Caries." Baillière, Tindall and Cox.

Various foods were used as stimuli; for example, bread and butter, cake, bananas, carrots, meat, apple, lemon, &c. Some of the results obtained are given below.

(1) *Quantity and alkalinity.* The quantities were measured to

0·05 c.c. and the alkalinity estimated by titration with $\frac{N}{50}$ H_2SO_4. The indicator used was weak methyl orange. The alkalinity was expressed in c.c. of $\frac{N}{50}$ H_2SO_4, required to bring the methyl orange to neutral. The figures of the normal resting saliva were obtained by estimations of one individual's saliva on fifty consecutive days (Saturdays and Sundays excepted), two hours after a light mid-day meal, which day by day was consistently similar as regards the articles and quantity of food consumed.

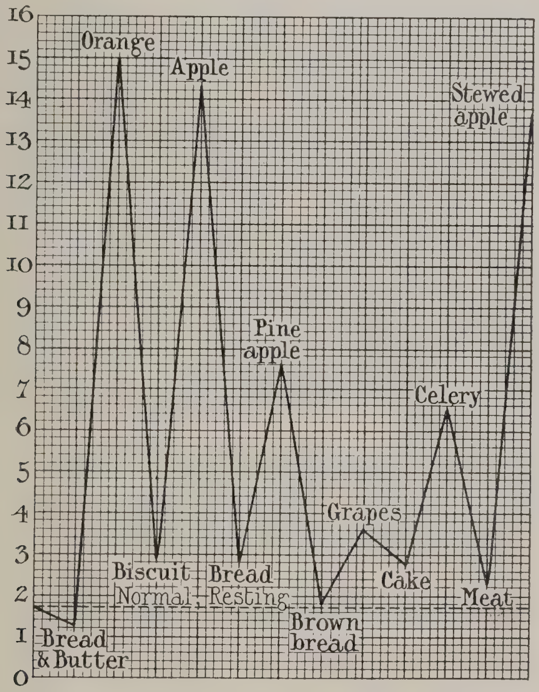

FIG. 728.[1]—Chart showing the variation in salivary secretions during the mastication of various articles of diet.

It was found that the quantity of saliva both from the parotid and from the submaxillary and sublingual glands varies per minute according to the different stimuli.

(*a*) In the case of the parotid gland one stimulus may produce ten times more secretion than another stimulus, and in the case of the submaxillary eight times as much.

(*b*) The total quantity may vary in the proportion of eight to one.

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[1] From *Brit. Dent. Journ.*

(*c*) The parotid saliva never exceeds one-third of that from the submaxillary and sublingual glands and may be as low as one-thirtieth.

(*d*) The softest and least flavoured articles of diet produce the smallest secretion.

From the chart, fig. 728, it will be seen that the total alkalinity is far greater with a fruit stimulus than with a carbohydrate stimulus. The variations in the total output of saliva are similar to the variations in the total alkalinity.

An acid diet progressively increases the alkalinity of the secretion of the saliva. The use of alkaline dentifrices, on the other hand, has a marked depressing effect both on the amount of secretion and on the alkalinity.

(2) *Phosphates.* During the mastication of acid substances not only is the quantity of phosphates increased per c.c. but the amount per minute is also increased. Alkalies cause a diminution, but sodium chloride slightly increases the amount of phosphates.

(3) *Chlorides.* Saliva under normal conditions contains from three to five times as much chlorides as phosphates. Natural stimulation increases the chlorides more rapidly than the phosphates, but when depression occurs from the use of alkalies, the decrease of chlorides is proportionately three times as great as the decrease of phosphates.

(4) *Ptyalin.* Acid substances call forth the greatest amount of ptyalin ferment per minute, while substances like bread and butter are extremely feeble excitants of ptyalin secretion.

(C) ADAPTATION OF THE SALIVARY SECRETION TO DIET

This subject has been investigated by C. H. Neilson and O. P. Terry.[1] Experiments carried out on dogs have shown that the amylolytic power of the saliva of bread-fed dogs was greater than that of meat-fed dogs. A dog was fed for fourteen days on a meat diet, and the glands on one side were then removed. The dog was then placed on a bread diet for fourteen days, after which the glands on the opposite side were removed. The extract of the glands removed after the meat feeding showed only a small amylolytic power, while the extract from the glands after the dog had been fed on bread showed a much greater amylolytic power.

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[1] *Amer. Journ. of Physiol.*, vol. xv, p. 406.

(D) BACTERICIDAL PROPERTIES

Sanarelli[1] states that human saliva possesses the power of destroying micro-organisms when their number is not considerable, and even when it fails to destroy them, as in the case of the germ of pneumonia, it seems capable of modifying their normal characteristics by weakening them, and then rendering them completely inactive. Sanarelli experimented chiefly with the more common of the micro-organisms which are found in the mouths both of healthy and unhealthy individuals, namely, the *Staphylococcus pyogenes aureus*, *Streptococcus pyogenes*, the bacillus of diphtheria, the *Micrococcus tetragenus*, the diplococcus of pneumonia, the typhoid bacillus and the cholera spirillum. The saliva was filtered with a Chamberland filter and experiments were practised by the plate method.

Hugenschmidt[2] records numerous experiments with filtered saliva, and he has come to the conclusion that " the bactericidal action of the saliva appears to be very problematical." He was only able to detect it on the torula and *Staphylococcus aureus*. The saliva, he considers, has an important mechanical action, as it dilutes the bacteria, glueing them together so that they are swallowed and destroyed in the stomach by the action of the gastric juices. In connection with these experiments it has been pointed out by Miller that the effect of filtering the saliva is to deprive it of the greater part of its nutrient matter, so that it contains but a small fraction of the organic matter usually present in culture media. The refusal of bacteria to grow in such a fluid is possibly due to inanition and cannot, therefore, be regarded as a proof of antiseptic action.

In a series of experiments carried out by Miller[3] this source of error was excluded. Bouillon of double strength made from beef extract, peptone and sugar was prepared, and 5 c.c. placed in three tubes, A, B and C. To tube A, 5 c.c. of the saliva of a person immune to caries were added; to tube B, 5 c.c. of the saliva of a person not immune; and to tube C, the control, 5 c.c. of water. By this means the strength of the bouillon was reduced to the normal. The saliva was filtered through a Chamberland filter. The three tubes were inoculated with a bacterium obtained from carious dentine and incubated. As a result of this experiment Miller found that the saliva exerted no retarding influence on the growth of the organism.

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[1] *Centralblatt für Bakteriologie*, vol. x, p. 817.

[2] *Dental Cosmos*, October, 1896.

[3] " Introduction to the Study of Immunity in its Relation to the Diseases of the Mouth and Teeth," *Dental Cosmos*, vol. xlv, p. 1, January, 1903.

Experiments were then undertaken to test the rate of acid production. Bouillon, made of beef extract, peptone and sugar, of five-fold strength was taken, and to one part of bouillon four parts of each saliva were added. The tubes were then inoculated and the rate of acid production determined by the amount of a 5 per cent. solution of bicarbonate of soda required to neutralize the amount of acid formed. One experiment gave the following results:—

[Relative Amount of Acid Formed.

	In 42 hours.	In 62 hours.	Total.
Saliva of A	9·5	5·5	15·0
,, B	9·0	7·0	16·0
,, C	10·0	7·5	17·5
Control water	9·0	7·0	16·0

The amount of acid produced in the control tube containing water and the three tubes containing saliva showed no appreciable variation. Further experiments were undertaken on the undiluted saliva, non-altered saliva, &c., with similar results, and the conclusion Miller came to was "That mixed human saliva—whether filtered or unfiltered in its normal state or condensed by evaporation over the water-bath, or at the temperature of the human body—does not possess the power to prevent or retard processes of fermentation or putrefaction."

Protective properties have been accredited to the buccal mucus. Miller, however, came to the conclusion that "growths of bacteria and fermentation and putrefaction processes take place in oral mucus quite as readily, if not more so, than in the mixed saliva of the same person." He says that "it seems hardly probable that the buccal mucus can contain any bactericidal property in view of the fact that the mucous membrane of the mouth is invariably found to be covered with large masses of bacteria." On the other hand, the action of mucus in other cavities of the body must not be lost sight of. Wurtz and Lermoyez have shown that "after three hours contact with the nasal mucus at 38° C. the spores of the *Bacillus anthracis* are killed, while the *Staphylococcus aureus*, the streptococcus and the *B. coli* are greatly attenuated." Thomson and Hewlett[1] also found the nasal mucus possessed a retarding influence, but no bactericidal property.

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[1] *Lancet*, 1897, p. 860.

The mucus secreted normally by the cervix uteri destroys and attenuates the germs of the vagina and prevents them from penetrating into the uterine os; still further, in connection with the bronchi, Widal considers that "the innumerable glands which exist on the surface of the respiratory mucous membrane secrete constantly a mucus which has a bactericidal action." Arguing by analogy, it would certainly seem probable that the mucus in the mouth when healthy does exert a protective influence against infection.

The possibility of fresh saliva containing protective substances is shown in the case of East Indian snake-charmers. These individuals treat snake-bites by applying saliva to the wounds, they themselves having acquired immunity by being bitten first by very small snakes and gradually by larger ones, the antibodies thus formed in the blood passing into the saliva.

It is probable that *phagocytosis* plays an important rôle in protecting the oral cavity against pathogenic organisms. Hugenschmidt refers to the chemiotactile properties of mixed saliva, and shows that non-filtered human saliva possesses positive chemiotactile properties. This he demonstrates by the following experiments: Human saliva ejected in the morning was left for some time in an experiment glass; the upper part of the liquid, which had become clear, was then introduced in small quantities into capillary tubes which were each closed at one extremity; the tubes were then inserted into the peritoneal cavity of a guinea-pig and left for eight hours, after which they were removed, and, on being examined, leucocytes were found to have formed a dense plug 2 mm. long. In another experiment, in which the saliva was kept for twenty-four hours in an oven at 37° C., and in which the number of microbes had greatly increased, the plug formed by the leucocytes in the capillary tube was visibly larger, thus showing that the attraction exerted by the leucocytes is in relation to the intensity of the culture, and consequently with the quantity of the microbian products present in the liquid. From these experiments it may be inferred that when there exists in the interior of the alveolar process after an extraction, or in any other part of the buccal parietes, a cavity where the saliva can remain and become the medium of an abundant culture, the saliva presents chemiotactile properties in relation to the quantity of microbes which have developed in it. The leucocytes of the neighbourhood will be energetically attracted towards the part, and will, in a very marked way, accomplish their protective action.

Experiments in which the saliva of a guinea-pig was introduced into the same animal's peritoneal cavity produced the same results as human saliva, thus demonstrating the fact that the saliva of one animal attracts the leucocytes of the same animal. After it had been proved that saliva possessed positive chemiotactile properties, experiments were made with a view of ascertaining whether the phagocytes of an animal are capable of englobing and digesting the microbes which are cultivated in the salivary secretions. That the phagocytes of an animal are capable of englobing and digesting the microbes which are present in the salivary secretions is shown by the following experiments:—

Human saliva which had been allowed to stand and clarify was mixed with leucocytes from guinea-pigs. The mixture was placed in an oven at 37° C. for an hour, after which it was placed on slides, fixed, and coloured by Ehrlich's process. Microscopical examination of the slides showed that the leucocytes had taken up the microbes with great avidity. Similar experiments with the same animal gave similar results. In another experiment recorded, the activity of the destruction of the microbes by the phagocytes is clearly demonstrated. "A trace of saliva was taken from a guinea-pig and from this preparations were made and stained, some with methyl blue and others by the Gram method. This done, a wound was made in the gum and in the median line of the mandible, the mucous membrane being removed and the bone scraped. Twenty-four hours later the wounds presented a white coating consisting of leucocytes, almost all polynuclear, some mononuclear. These leucocytes, by proper stainings, were found to contain an abundance of microbes similar in form and character of stain to those seen in the preparation of the saliva. A considerable number of the englobed microbes were less energetically stained than those from the surrounding liquid, thus demonstrating their degeneration."

In the experiments above recorded the saliva was used unfiltered and therefore mixed with microbes. In order to test whether filtered saliva possessed these chemiotactile properties, the following experiment was carried out: Saliva filtered through a Chamberland filter was introduced into six capillary tubes each of which had one end closed. In six other tubes cholera culture was introduced, and into another six physiological serum. These three bunches, separately attached, were placed in the peritoneal cavity of a guinea-pig and left for ten hours. Examination at the end of that period showed dense plugs of leucocytes in the tubes containing cholera culture, but few leucocytes in the tubes containing filtered saliva, and no trace of any in the tubes containing physiological serum. "It would thus seem that the positive chemiotactile properties of mixed saliva depend upon the presence of micro-organisms."

But phagocytosis is probably not the only means by which the oral cavity is rendered immune to pathogenic organisms, for it is probable that the epithelial cells and also the vital antagonism of the microbes lend their aid. The epithelial cells of the oral cavity are constantly being replaced, this desquamation being especially active during the act of mastication. Although the epithelial cells do not possess phagocytic properties, nevertheless they have attached to their surface and are also to a certain extent penetrated by scattered bacteria. These cells on being dislodged are carried away with the organisms to the stomach where the latter are destroyed.

Another factor to be considered in connection with the immunity of the oral cavity to infection may be the antagonism of organisms to one another, the organism not common to the mouth succumbing to those normally present. The following experiment, carried out by Miller on himself, throws light on this question. He thoroughly rinsed his mouth with a bouillon culture of *Bacillus prodigiosus* containing over 2,000,000,000 bacilli. The number of bacilli in a loop of his saliva was ascertained at the beginning of the experiment, and at the end of one, two, three and six hours, with these results:—

Bacteria at beginning	97,600
,, after 1 hour	1,220
,, ,, 2 hours	127
,, ,, 3 ,, ...	17
,, ,, 6 ,, ...	0

His mouth at the end of three hours was practically free from organisms. The elimination of pathogenic organisms such as those of tubercle, typhus, &c., which are constantly finding an entrance to the mouth, may be brought about by a struggle with the normal flora of the cavity.

To sum up, the facts quoted above would seem to indicate that the soft tissues of the mouth are rendered immune—

(1) By the process of phagocytosis.

(2) By the normal functional activity of the mouth, causing desquamation of the epithelial cells with the adherent bacteria, the latter being destroyed by the gastric juice.

(3) By the mutual antagonism of the micro-organisms.

(E) THE RELATION OF THE SALIVA TO CARIES OF THE TEETH

A free flow of saliva by cleansing the teeth of food debris lessens their liability to caries. The phosphates probably have a protective action upon the teeth. Lactic acid "readily combines with phosphates to form harmless lactates and the lactic acid will be more readily and rapidly satisfied if the phosphates are in solution, than if they are in a solid and extremely hard mass like enamel." "Acid phosphates may be formed, but there is no evidence to show that these, under such circumstances, can exert any effect upon the enamel surface."[1]

Ptyalin, in Pickerill's opinion, is an important protective agent for the teeth. It converts the insoluble and adhesive substances, such as starch, into a soluble and easily removable substance (maltose) and, provided that there is a free flow of saliva, stagnation is obviated and circulation promoted. He considers that a small amount of ptyalin is harmful. His argument is as follows:—

(i) In the conversion of starch into maltose by the action of ptyalin, erythro-dextrin and achro-dextrin are formed as intermediate products.

(ii) The rapidity of action depends upon the amount of the ptyalin and its concentration.

(iii) If the ptyalin is present in considerable amount the conversion into maltose is rapid and it is quickly removed by the flow of saliva.

(iv) If the ptyalin is small in amount, the dextrin formed will remain longer and with the maltose cling to the teeth. The mouth organisms will convert the maltose into lactic acid, and this in its turn will destroy the ptyalin, with the result that the "starch is literally gummed to the teeth, to be slowly but surely transformed into lactic and other acids."

The effect of mucin may be harmful or beneficial. When partly dissolved it is very viscous and in this condition is harmful as it tends to bind food debris to the teeth and so promotes stagnation. Acid substances precipitate mucin and alkaline salts are taken down in the precipitate, and the teeth are coated with a thin organic alkaline film. The mucin is acted on by bacteria, and alkaline products are formed which tend to neutralize any acid formed by fermentation.

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[1] The method adopted to estimate the phosphate was "that of titration with N/5 uranium nitrate. The saliva was diluted, and there was added a small quantity of sodium acetate acidified with acetic acid. The indicator used was potassium ferro-cyanide" (Pickerill).

The relation of potassium sulphocyanate to caries has been freely discussed during recent years. It is maintained by certain authors that the presence of sulphocyanates diminishes the liability to caries. The amount of potassium sulphocyanate in the saliva is very small, varying from 0·0075 per cent. to 0·03 per cent. Miller[1] has shown that potassium sulphocyanate in the strength met with in saliva has no retarding influence.

(F) SALIVARY CALCULI

A calculus occasionally forms in the ducts of the salivary glands. It may form in the substance of the gland, but this is very rare, as a deposit formed in this situation is usually washed into the duct. If the deposit is situated in the substance of the gland, it gives rise to serious inflammatory trouble; the flow of saliva from the duct of the gland is obstructed and the trouble may lead to abscess or even destruction of the gland.

A calculus is more frequently met with in the submaxillary ducts than in the parotid duct, and this is possibly due to the mucoid character of the submaxillary secretion and to the position of the duct rendering it more liable to injury.

Symptoms.—When a salivary calculus is deposited in the duct of a gland, the obstruction, which may be either as small as a millet seed or larger than a filbert, will give rise to a swelling of the duct and gland. Salivary calculi situated in the floor of the mouth may simulate ranula, from which they should be diagnosed by noting that in the case of salivary calculus the flow of saliva is stopped, and that a small probe cannot be passed along the duct, while careful digital examination will reveal a hard concretion in the duct.

At times, the presence of a salivary calculus in Wharton's duct will give rise to appearances and symptoms suggestive of malignant disease. In one case seen, the floor of the mouth was much swollen, the tongue pushed upwards, and there was a fungating excrescence surrounded by tissue in an indurated condition. The tissues covering the mandible and the neck were much swollen, and the lymphatic gland lying in the submaxillary region enlarged. The patient presented a cachectic appearance. The whole condition seemed typical of malignant disease.

In a case recorded by T. E. Constant, a calculus in the parotid duct caused symptoms simulating a dento-alveolar abscess.

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[1] *Dental Cosmos*, January 1, 1903.

Origin.—The cause of the formation of salivary calculi is not clear. It has been suggested that they arise in a manner similar to other calculi, by precipitation and secretion of the salts around a foreign body. This view is supported by the occasional presence of a nucleus of foreign matter within a salivary calculus. A minute foreign body can easily enter the main salivary ducts and form a nucleus.

Bland-Sutton[1] considers that the principal conditions determining the formation of gall-stones are catarrh of the epithelial lining of the gall-bladder plus the presence of micro-organisms, and it is possible that salivary calculi may arise in a similar way.

Size.—Salivary calculi vary considerably in size. They may weigh as much as 25 gr., and the fusiform-shaped calculi reach 1 in. in length.

Treatment.—Treatment consists in making an incision over the hard swelling and removing the calculus. It is best to secure the concretion in a fixed position before making the incision. Cases remaining untreated may give rise to suppuration, either in the region of the duct or in the gland itself. The abscess at times opens externally and thus gives rise to a salivary fistula. Salivary calculus as a deposit on teeth will be considered in the following chapter.

A case in which six calculi were found in the parotid duct in a child aged 13 is recorded.[2]

(G) DEGENERATION OF THE SALIVARY GLANDS

Lymphoid degeneration of the salivary glands has been described by W. S. Handley.[3] The change consists in the total destruction of the epithelial elements of the gland, accompanied by hypertrophy of the lymphoid elements. The microscopical structure of the gland becomes practically indistinguishable from that of the tonsil or of a lymphatic gland, and the saliva-secreting function of the gland is destroyed.

The clinical features of the condition are pain, tenderness and swelling of the gland, accompanied by a mucoid discharge. A small calculus is sometimes present in the duct. In the cases recorded, the primary change would appear to be chronic catarrh of the salivary duct due to bacterial invasion from the mouth. The most satisfactory treatment is excision of the gland.

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[1] "Gall-stones and Diseases of the Bile-ducts." Nisbet, 1907.

[2] *Amer. Med. Surg. Bull.*, July 25, 1897.

[3] *Trans. Odonto. Soc.*, vol. xxxix, p. 186.

A case of purulent discharge from both parotid glands has been placed on record by C. S. Tomes.[1] The trouble dated from an attack of typhus thirty years previously. The discharge was indistinguishable from pus, but its power of affecting starch had not been destroyed.

(H) INFECTION OF THE SALIVARY GLANDS

Infection around the orifices of the ducts of the salivary glands may spread through the ducts to the substance of the glands. The condition starts by a thickening of the papilla guarding the orifice of the duct; the duct becomes a thickened and painful cord, and dilates during secretion. If the gland substance becomes involved there is considerable swelling and tenderness which is increased during salivary secretion. A calculus may form in the duct; the calculus if small has a tendency to alter its position, but if large it is stationary. The calculus is always the seat of great tenderness. The condition is usually asymmetrical; when symmetrical it may simulate mumps.

Septic conditions of the mouth are always present. Removal of the sepsis is usually followed by a relief of the symptoms, but in cases of long standing it may be necessary to slit up the duct or even remove the gland.[2]

Acute infection may occur in the course of acute illnesses or operations. It is a severe disease and frequently has a fatal termination.

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[1] *Trans. Odonto. Soc.*, December, 1891, p. 32.

[2] See paper by W. G. Spencer, *Brit. Med. Journ.*, January 28, 1922.

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CHAPTER XX

Deposits on Teeth

Salivary Calculus—Subgingival Deposits—Stains

(A) SALIVARY CALCULUS

CALCULUS derived from the saliva may be deposited on the teeth or artificial dentures. This form of calculus is familiarly known as "tartar."

(1) Situations.—The lingual surfaces of the mandibular incisors and canines and the buccal surfaces of the maxillary molars are the most common situations of these deposits. The deposition of salivary calculus is assisted by: (*a*) Rough surfaces, as in "hypoplastic" teeth; (*b*) the presence of foreign bodies, such as wires or clasps on dentures which are not kept clean.

(2) Varieties.—Clinically there are two varieties, "soft" and "hard." The distinction is purely arbitrary. The difference depends upon the rate of deposition. *Rapidly deposited tartar* is soft in character, buff-coloured, and occurs in large quantities. *Slowly deposited tartar* is dark and hard in character, and is exceedingly tenacious. The colour of the tartar is affected by conditions which produce staining, such as tobacco smoking.

(3) Mode of Deposit.—The deposit, which may attain considerable proportions, starts at the cervical margin and, as it increases, tends to assume a wedge shape, the base being towards the gum. The friction of mastication removes the calculus and the disuse of teeth favours its deposition.

The calculus is formed by precipitation of the salts from the saliva. Calcium carbonate and calcium phosphate are insoluble in pure water, but soluble in water containing carbonic acid gas. When the saliva reaches the oral cavity, the carbonic acid gas passes out of solution and the lime salts are precipitated.

In the opinion of H. Prinz[1] the formation of salivary calculus is of the nature of a physico-chemical process and depends upon the co-ordination of three basic factors. (*a*) The presence of a supersaturated solution of calcium salts in a colloidal medium, i.e., the saliva; (*b*) its stagnation in a sheltered place; and (*c*) a parental or foreign inanimate substance having a hard, rough surface which serves as a nucleus for its attachments. "The stagnated, mixed saliva, in conformity with Gibb's law of surface tension, concentrates its colloids upon its own surface. At first a faint nubecula appears which by its own concentration slowly forms a dull lustrous pellicle. Simultaneously the solvent power of the saliva is thereby physically diminished, thus liberating the crystalline calcium salts which are at once caught by the freshly formed colloidal stroma. The pellicle gradually becomes specifically heavier than the surrounding fluid, and slowly sinks or is forced along the line of least resistance by the movements of the cheeks, lips and tongue until it meets with some obstruction. Any sheltered surface which offers a suitable rough surface for its attachment, where the film can remain undisturbed, may serve as a nucleus for its permanent retention. Incidentally, the suspended, very tenacious mucin has settled itself within the same region even before the pellicle is completely formed, and most likely it is primarily responsible for the initial starting-point for the calcareous deposit. The freshly precipitated flocculent sediments receive continuously additions from the uninterrupted slowly flowing saliva; food debris, hæmoglobin and other extraneous matter lend body and colour to the deposit and its own increase condenses its bulk. The initial focus for tartar formation is thereby created; its future growth and physical characteristics are matters of time and circumstances."

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[1] *Dental Cosmos*, 1921, p. 373.

(4) Composition.—Berzelius gives the composition of the calculus as follows:—

Phosphates of lime and magnesia...	79·0
Salivary mucus	12·5
Ptyalin...	1·0
Animal matter soluble in HCl	7·5
	100·0

These figures can only be approximate. Stevenson gives the following analyses of the two varieties:—

	Water and organic matter	Inorganic
Soft tartar	21·48	78·52
Hard tartar	17·51	82·49

The deposit found on the buccal surfaces of the maxillary molars is composed almost entirely of calcium carbonate. The deposit on the lingual surfaces of the mandibular incisors contains much more calcium phosphate than carbonate, owing to the excess of the phosphates in the submaxillary secretion.

(5) Treatment.—The treatment of salivary calculus consists in thoroughly removing all the deposits and polishing the surfaces of the teeth. The force for detaching the deposit may be used in a direction towards the gum or away from it. Force is used towards the gum when there is much tartar, and away from it when the quantity is small. When using force in a direction towards the gum, the right hand should be steadied by placing a finger or fingers upon the teeth, the cutting edge of the instrument being placed upon the tartar and a pushing motion used, when the tartar will be found to come off in large flakes. The greater part of the tartar can be removed in this way, the remaining adherent portions being removed in a direction from below upwards, the instrument being prevented from slipping by supporting the hand on the cutting surface of the teeth. At the completion of the scaling, the teeth should be polished with fine pumice applied by means of a circular brush on the dental engine.

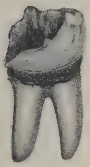

Fig. 729.—Showing well-marked deposit around the neck of a mandibular molar.

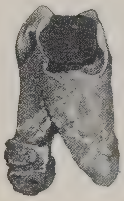

Fig. 730.—A maxillary molar showing large deposit of calculus on the apical portion of the palatine root.

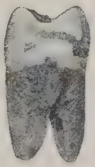

Fig. 731.—A maxillary molar showing irregular deposit of calculus over a large portion of the surface of the root.

(B) SUBGINGIVAL DEPOSITS

In dealing with marginal gingivitis and also chronic periodontitis, reference was made to the frequent presence of **calculus under cover of the gum margin.** In character it is hard and dark, and is found more frequently on the approximal surface than on the labial and palatal surfaces. The source of this deposit is not clear. The deposit is found on teeth where there is or has been a marginal gingivitis, and it would therefore appear to be derived from the products of inflammation which accumulate in the gingival trough. The presence of the calculus is generally marked by a hyperæmic condition of the gum margin. The roots of teeth which have been the subject of chronic suppurative periodontitis are often covered with a calcareous deposit (see figs. 729 to 731). Analyses of these deposits show them to be composed mainly of phosphates. Oxalates are sometimes present.

Occasionally, calculus is present and yet the gum tissues appear to be quite healthy, but in such cases it is probable that marginal gingivitis has occurred at an earlier period.

Treatment.—The deposit must be removed and the condition of the gum, or periodontal membrane, treated.

(C) STAINS[1]

(1) Green Stain.—A green stain is often found on the teeth, especially in the young. The colour varies from a greyish-green to bluish-green. It appears on the maxillary teeth more frequently than on the mandibular. The labial surfaces of the anterior maxillary teeth are the most frequent sites, the discoloration commencing at the gingival margin and encroaching on the surfaces in a direction towards the cutting margin. At times, more than half the surface is covered. The stain may extend to the approximal or even to the gingival surfaces. The stain may be limited to any pits, grooves, or depressions present on the surface of the tooth. The green stain is nearly always a sign of lack of cleanliness on the part of the patient. The stain is intimately connected with the enamel cuticle. Removal of the stain by acids leaves a colourless surface behind. Green stain may occur beyond the enamel margin on the teeth of adults.

Cause.—The origin of green stain is not clear. The following facts are known: The colouring matter is characterized by its insolubility in nearly all the ordinary solvents, viz., glycerine, alcohol, chloroform, turpentine, &c.; tincture of iodine has no marked decolorizing effect. The colouring matter is rapidly destroyed by chlorine and hydrogen peroxide. Calcination experiments show that the green stain deposit may be either of an organic or inorganic nature. The theory that the green stain is produced by chlorophyl is negatived by the fact that the stain is not soluble in ether, chlorophyl being readily soluble in ether. There is reason to believe from experimental investigations that in certain cases the green colour is to be attributed to the presence of sulpho-methæmoglobin.

The relation of green stain to enamel decalcification is not clear. When the stain is removed the enamel appears quite normal in the majority of cases, but in some cases the surface shows signs of decalcification.

Treatment. The stain should be removed by means of suitable wheels or brushes on the dental engine, a little powdered pumice stone being used to increase the abrasive action. Acid applications are *not* to be used.

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[1] The matter contained in the following section relating to "stains" has been obtained almost entirely from an excellent paper by Miller (*Dental Cosmos*, April, 1894) entitled "The Deposits upon the Teeth with Special Reference to Green and Metallic Deposits."

(2) Metallic Stains.—(*a*) *Copper.*—The teeth of workers in copper invariably show a green stain. Miller examined 150 persons who had been working in copper for more than a year, and found distinct discoloration of the teeth in all of them. The colour varies from green to dark dirty green, reddish-green, bluish-green, greenish-blue to bluish-purple, the latter being seen in "phosphor-bronze" workers. Persons using brass musical instruments at times show staining of the teeth.

The gingival margin of copper workers is hyperæmic, owing to irritation from the more or less oxidized particles of the metal which may have worked their way up into the gums.

(*b*) *Iron.*—Iron seems to produce a brown stain of varying tints. In workers in iron, Miller found that nearly all showed brown spots or deposits on their teeth, the mandibular teeth being more frequently discoloured than the maxillary. Medicines containing iron may stain the teeth if the mouth is not cleansed each time after taking the medicine. The forms of iron detrimental to the teeth are those containing free acid, such as the perchloride.

(*c*) *Mercury.*—Deposits of mercury in the form of sulphide are seen on teeth filled with amalgam. These deposits occur also on the teeth of patients subjected to prolonged mercurial treatment, the mercury affecting the teeth through the saliva. The stain may be due to the use of mouth-washes containing mercury. The presence of the mercury on the teeth can be demonstrated by chemical tests.

(*d*) *Lead.*—Lead poisoning may produce a blue line in the gum margins (p. 576). According to Hirt,[1] in chronic lead poisoning the teeth are discoloured and appear dark brown at the necks, shading to light brown towards the occluding surfaces.

(*e*) *Nickel.*—A tooth from the mouth of a worker in nickel is figured by Miller. The deposit is thick and of an opaque bluish to greenish-black colour.

(*f*) *Silver.*—Silver, when used in the mouth, produces a dark stain, which is due to the formation of the sulphide. Silver employed in the form of silver nitrate stains the dentine and cement black.

Treatment of Stains.—The various stains can be easily removed by the use of abrasives.

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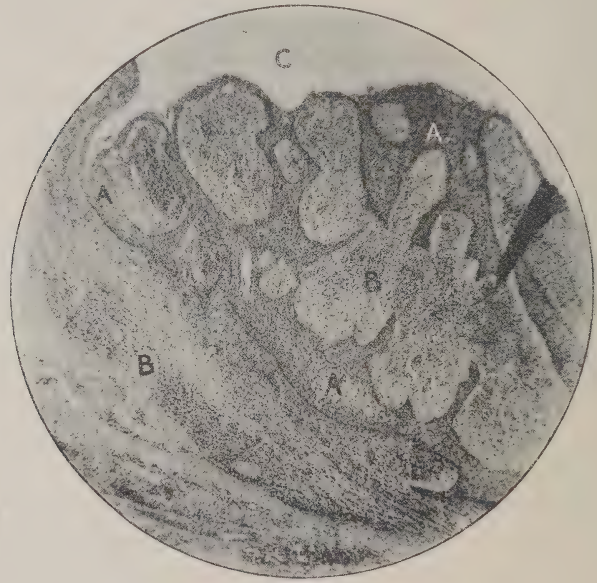
[1] Quoted by Miller.

CHAPTER XXI

Dental Cysts

THE cysts connected with fully developed and erupted teeth are termed dental cysts. These cysts have their origin from the epithelial masses met with in the periodontal membrane, and are usually caused by toxins from a septic tooth. In a few cases the cause is obscure (see p. 617). Dental cysts mostly occur in connection with the molar teeth, and are more commonly met with in the maxilla than in the mandible. They occur, although rarely, in connection with the deciduous teeth. The credit for the earliest description of the nature of these cysts belongs to J. G. Turner.



× 30 1½ in. obj., N.A. 0·15.

FIG. 732.[1]—Section of part of an epithelial granulome; C is placed in central cleft. A, trabeculæ of epithelial reticulum, central cells degenerating; B, mesoblastic tissue. (Turner.)

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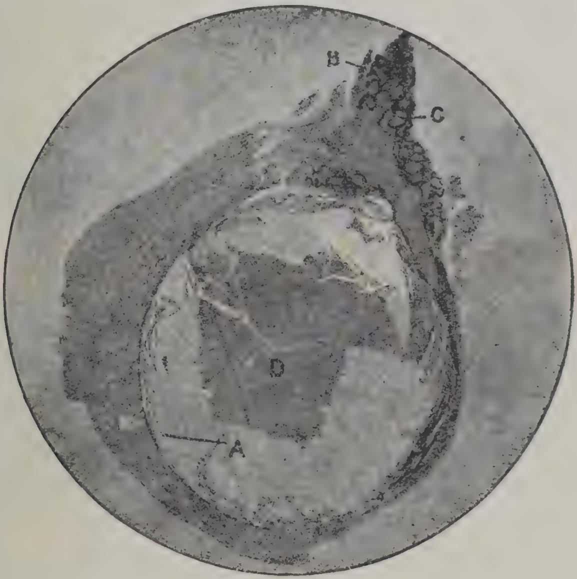
[1] For the figs. 732, 733, 748 to 750 I am indebted to J. G. Turner.

Morbid Anatomy and Pathology.—The formation of a dental cyst probably takes place as follows: The epithelium composing one or more of the aberrant masses proliferates and this eventually leads to the formation of a solid tumour, "epithelial granulome," the epithelial portion of which is sometimes in the form of a solid mass, but usually is found as a reticulum or sponge-work (fig. 732). The cells on the periphery of the mass are in a state of active growth, while those towards the centre are in a process of degeneration. Around this epithelial mass a capsule is developed from the surrounding mesoblastic cells. The cells towards the centre of the mass in time degenerate and liquefy, forming a distinct cyst (see fig. 733). The cells at the periphery continue to multiply and increase in size, shedding themselves towards the centre and at the same time undergoing a liquefying degeneration. In this way the fluid contents of the cyst are formed. The enlargement of the cyst is brought about by growth at the periphery and degeneration at the centre. As the cyst is a fluid growth it will displace the tissues and enlarge in the direction of least resistance.



× 9¼, 3 in. obj., N.A. 0·1.

FIG. 733.—Section of a small cyst attached to the apex of a root. A, epithelial lining; B, mass of epithelium; C, remains of epithelial reticulum; D, semi-solid contents. (Turner.)

Maxilla.—A cyst in connection with the incisor teeth forms, in its early stages, a cavity at the expense of the cancellous tissues. In growing, the cyst distends its bony walls and pushes its way (*a*) upwards towards the nasal fossa, (*b*) outwards through the external alveolar plate, (*c*) downwards and backwards through the palate. The morbid anatomy is shown in figs. 734 and 735. The cyst has destroyed the bone of the outer alveolar plate in one place; penetrated slightly towards the nasal process; extended towards the

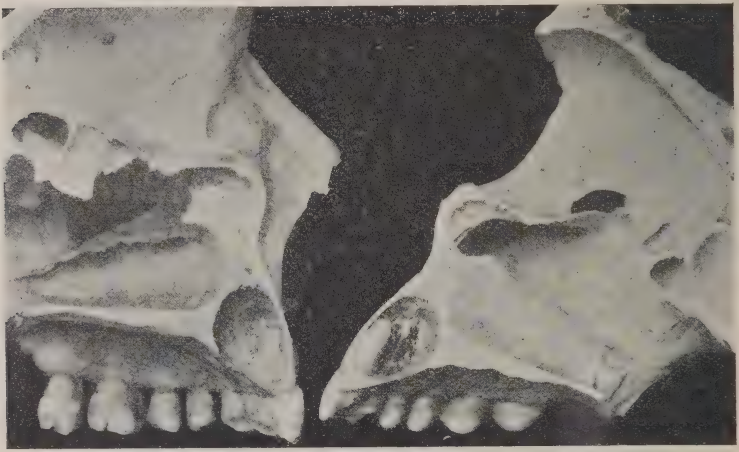


FIG. 734.

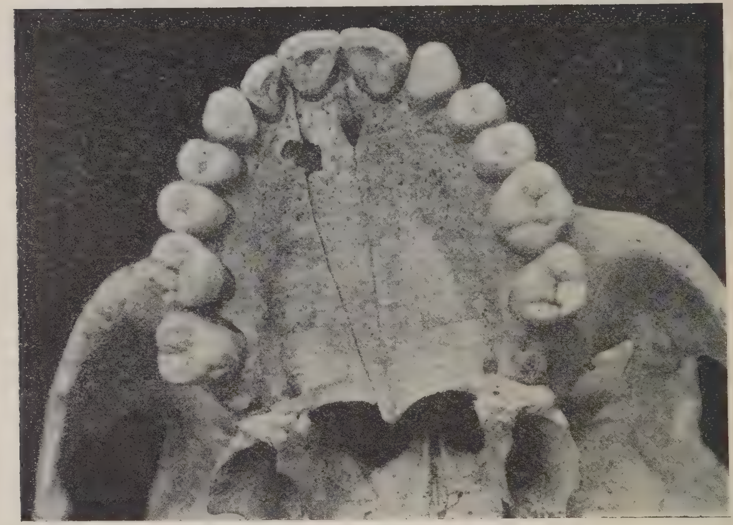


FIG. 735.

mid-line and laid bare the entire root of the second incisor and the upper third of the first incisor; pushed the palate downwards and in one place perforated the bone (fig. 735). A careful examination of this specimen does not suggest that the pulps of the incisors had died; and further, the alveolar process shows no signs of rarefying osteitis, but the incisors do show signs of excessive attrition in comparison with the remaining teeth.

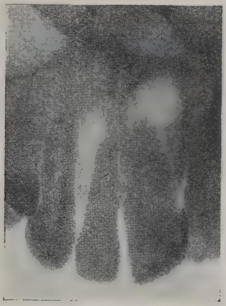


FIG. 736.

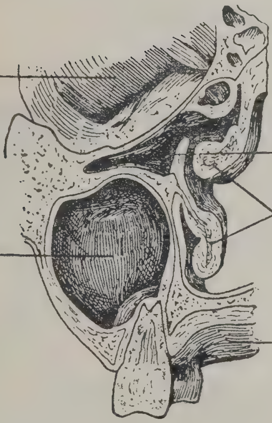


FIG. 737.[1]—Dental cyst pushing up the sinus until it is a mere slit beneath orbit. Modified from Zuckerkandl.

The radiogram, fig. 736, shows the presence of two small cysts in connection with the first and second incisors. A sinus led to the cyst in connection with the first incisor, the gum margin was healthy and intact, and the pulps of the teeth were healthy. The teeth had been regulated, and it is possible that the periodontal membrane had been injured by this operation and that the injury had stimulated the development of the cysts.

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[1] From *Journ. Brit. Dent. Assoc.*

In the region of the molars a cyst usually causes bulging of the outer alveolar plate, but the principal extension is towards the maxillary sinus, the floor of this cavity being pushed upwards until, in some cases, the cavity is almost obliterated (see fig. 737).

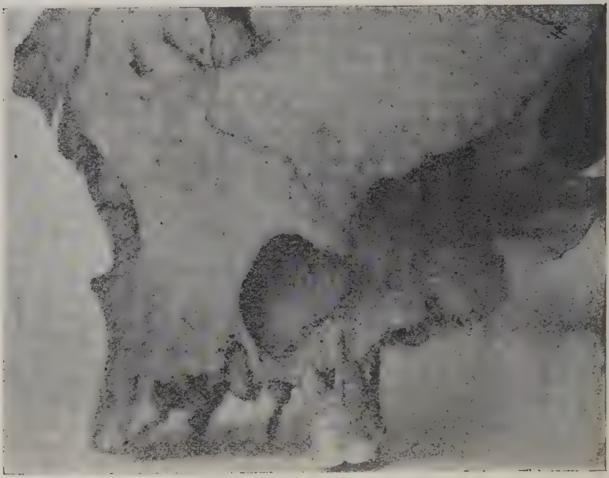


Fig. 738.

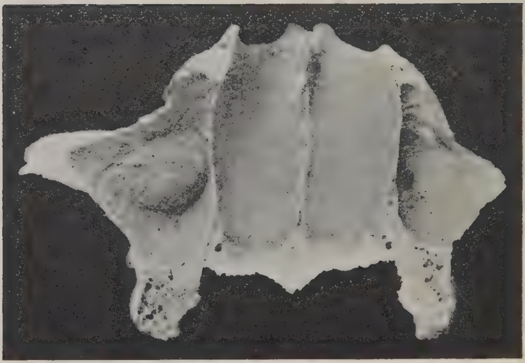


Fig. 739.—Section through the maxillary sinuses of the specimen shown in fig. 738. The cyst has pushed upwards into the sinus.

The morbid anatomy of a moderate-sized dental cyst in connection with a molar is shown in figs. 738 to 740.

In the living state this cyst would have formed a globular elastic swelling in the sulcus between the alveolar process and the cheek, the swelling being apparent on the face just under the malar process.

Should suppuration take place that part of the cyst wall which bulges towards the maxillary sinus is destroyed and that cavity becomes infected. The morbid anatomy of this type of case is shown in figs. 741 and 742. The cyst originated in connection with a molar and encroached on the maxillary sinus as shown in fig. 739. The horizontal section through the specimen shows the relation of the cyst to the sinus.

Large dental cysts are occasionally seen in the maxilla; in one case the cavity extended from the first incisor to the third molar.

Mandible.—In the mandible a cyst in the first stages destroys the cancellous bone and, as it increases in size, pushes outwards the external alveolar plate (see figs. 743 to 745). A cyst enlarges in length more than in depth and may form a cavity extending from the first premolar to the last molar. Large cysts may cause distension of both external and internal alveolar plates. Occasionally cysts involve the inner plate only.

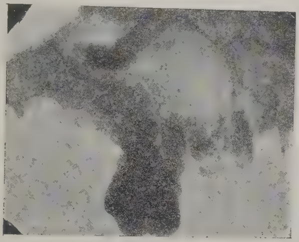


Fig. 740.—Radiogram of the specimen shown in fig. 738.

In fig. 746 is shown the radiogram of a case in which two cysts were present on the left side. The posterior cyst had arisen from the second molar, but in the case of the anterior cyst it was not possible to state whether it was of the nature of a dental cyst arising from the second premolar or a dentigerous cyst which had formed in connection with the unerupted misplaced canine. At the operation it was demonstrated that the anterior cyst was external to the canine, the capsule being closely adherent to the second premolar. The cysts had excavated the bone from the canine to the third molar and were separated from one another by a thin bony partition.

If a cyst in its growth comes into contact with the roots of

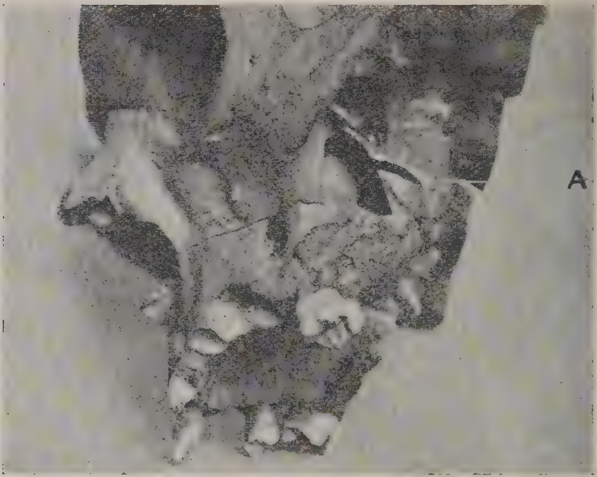


FIG. 741.—A, opening through the outer wall of the maxillary sinus to show the bony wall of the cyst.

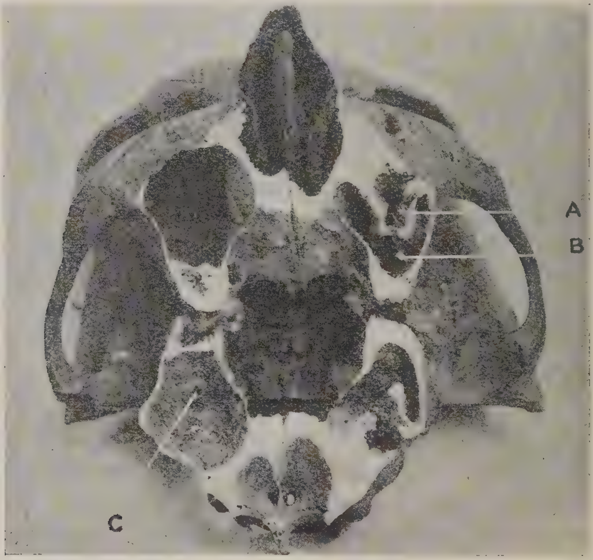


FIG. 742.—A, cyst; B, maxillary sinus; C, sinus opening through the floor of the maxillary sinus.

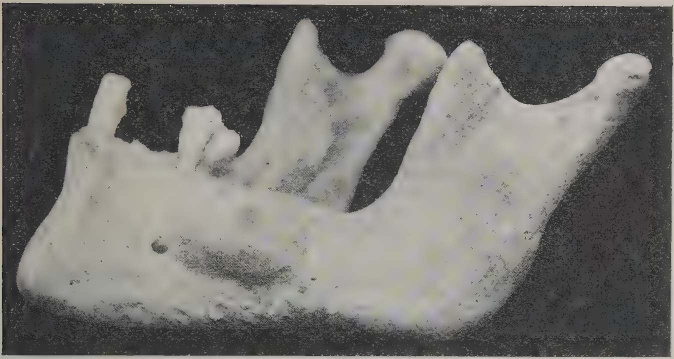


FIG. 743.—Mandible with a cyst in the molar region.

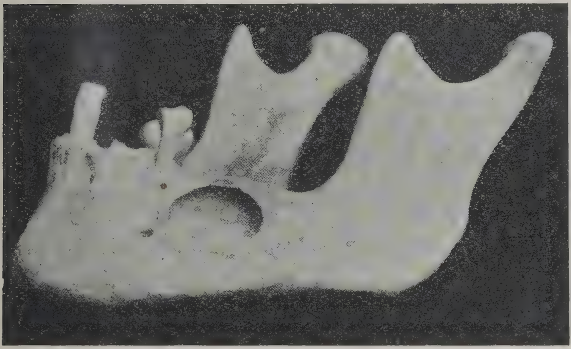


FIG. 744.—The specimen shown in fig. 743 with the outer plate of bone removed to show the cyst cavity.

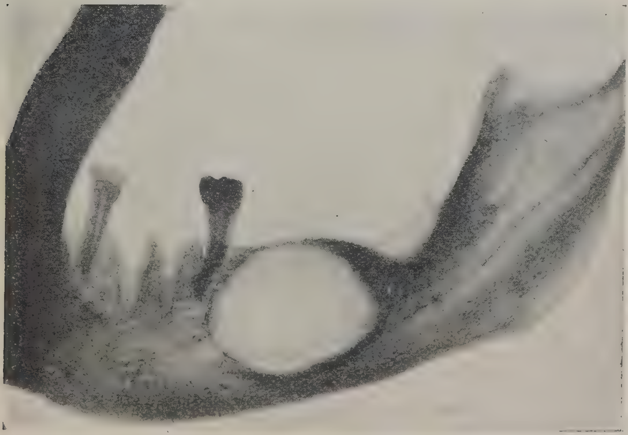


FIG. 745.—Radiogram of the specimen shown in fig. 743.

teeth, it does not bare them of their living surroundings, nor does the root from which the growth originates ever project bare into the cavity of the cyst.

Contents.—A dental cyst contains a viscid, translucent, mucus-like fluid, with crystals of cholesterin in suspension. *Chemical examination* shows the presence of proteids in the form of serum albumin and serum globulin, the latter being more abundant. There is an abundance of cholesterin, but no fats or fatty acids. A small quantity of nucleo-albumin is also present.

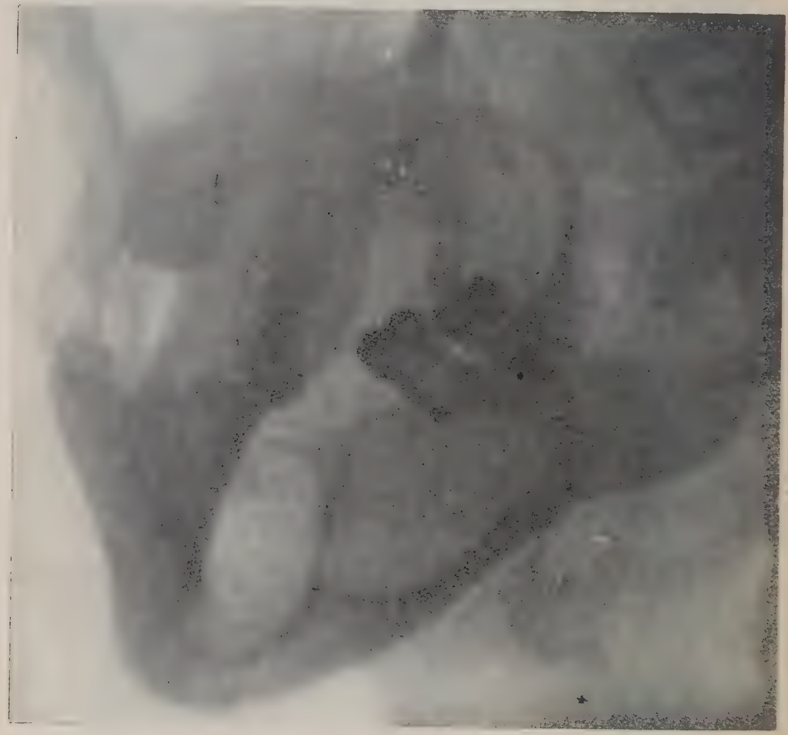
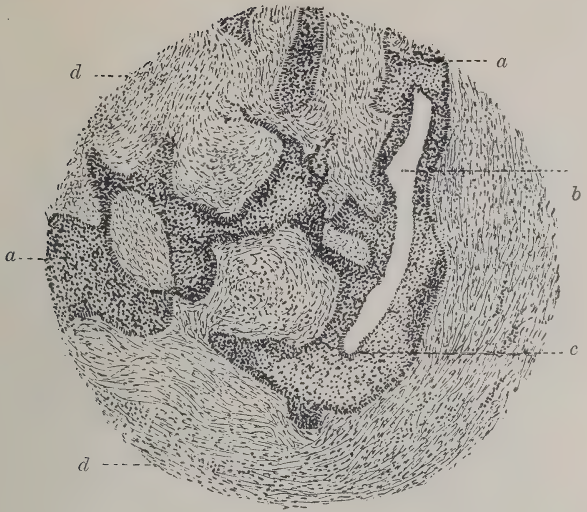


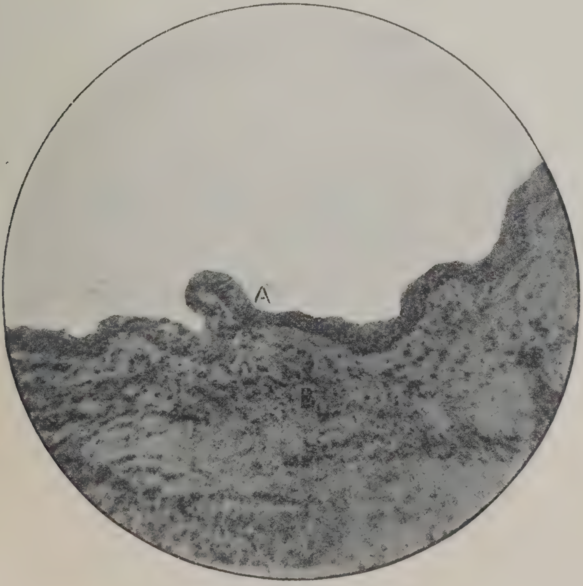
FIG. 746.—Radiogram of a case with two dental cysts in the mandible.

Structure of the Cyst Wall.—A section through the wall of a dental cyst shows an outer layer of connective tissue which forms the capsule. The capsule is lined with epithelium which may be of the stratified variety or the cells may tend to assume a stellate form similar in appearance to those of the body of the enamel organ. The cells which immediately border the cavity are in a state of degeneration (not colloid). In all the cysts examined by



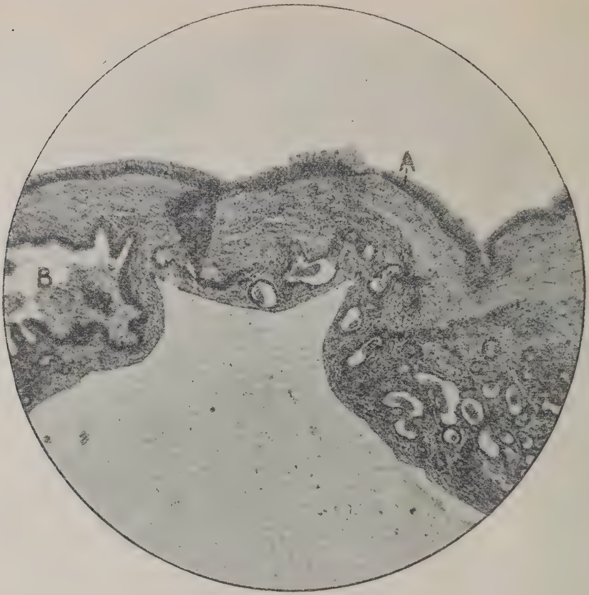
× 40.

FIG. 747.—Dental cyst—early stage of formation (from a drawing by A. Hopewell-Smith). *a*, epithelial cells; *b*, cyst cavity; *c*, a few ciliated columnar epithelial cells; *d*, connective tissue.



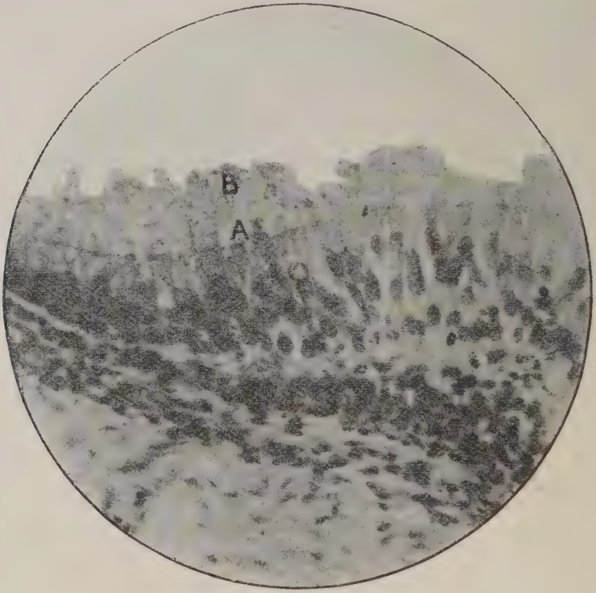
× 110, ½ in. obj., N.A. 0·4.

FIG. 748.—Section of wall of large dental cyst. A, thin regular lining of epithelium; B, connective tissue capsule. (Turner.)



× 43, 1½ in. obj., N.A. 0·15.

Fig. 749.—Section of wall of dental cyst showing columnar ciliated epithelium and loculi. A, columnar ciliated epithelium; B, large irregular acinus; C, smaller acini and tubules. (Turner.)



× 350, ⅛ in. obj., N.A. 0·6.

Fig. 750.—Section of dental cyst showing at A, ciliated epithelium; B, products of degeneration or secretion. (Turner.)

Mummery with a special fat stain (Sudan III) fat was present in many places as free globules. Occasionally, columnar ciliated epithelium is met with (see figs. 747 to 750).

The epithelial cell growth may be very active, and the connective tissue wall may be very thick and approach in structure a multilocular cystic tumour in which one loculus has far exceeded the others in growth. In some cysts micro-organisms can be demonstrated in the contents and also in the inner periphery of the wall.

The walls of dental cysts occasionally show an angiomatous structure (fig. 751).

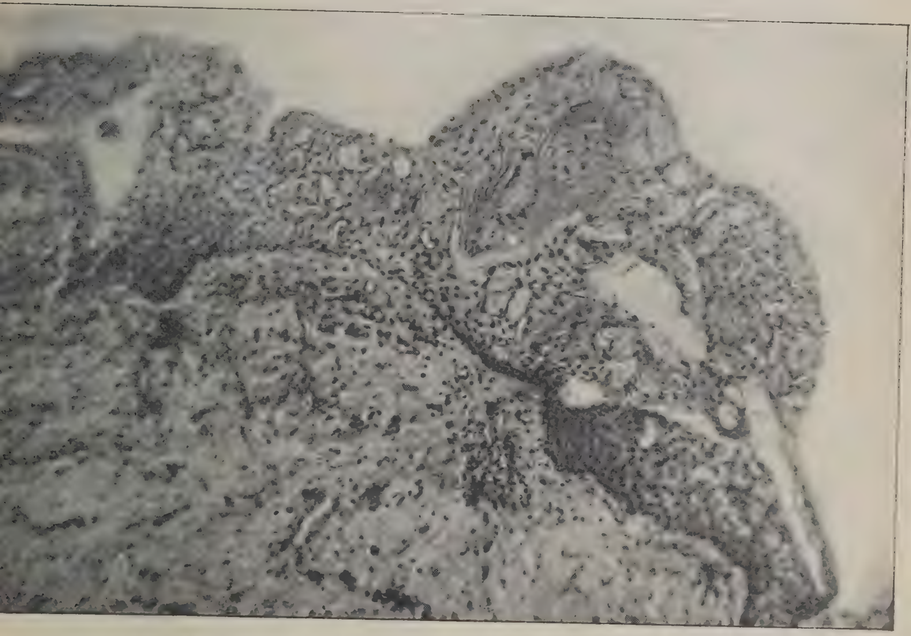


Fig. 751.—Wall of a dental cyst angiomatous in structure, and in a state of marked hyaline degeneration. (*Dental Cosmos*, July, 1918.)

Signs and Symptoms.—Dental cysts give rise to smooth, globular swellings. The growth is slow but progressive. Inflammatory symptoms are usually absent, the mucous membrane being freely movable over the surface of the tumour. Occasionally, dental cysts suppurate, and the symptoms of pus formation will then be added to the physical signs of tumour growth. Pressure on the surface of the swelling will frequently produce a peculiar sensation of crackling, demonstrating the presence of a thin layer of bone. When a cyst penetrates through the bone distinct fluctuation can be obtained, the fluctuating area being frequently bounded by a bony edge. *The differential diagnosis* from other swellings in the jaw is dealt with in Chapter XXXIII.

Treatment.—As a preliminary step the mouth should be rendered as clean as possible by the extraction of all septic teeth, except those in immediate relation with the cyst, and the removal of calculus. When the wounds resulting from the extractions have healed, the teeth in relation to the cyst should be removed; the muco-periosteum should then be raised and a portion of the bone taken away sufficient to leave a large self-draining cavity. The cyst is next shelled out and the wound packed with a suitable antiseptic gauze. In large cysts the removal of the whole cyst wall is usually unnecessary and is frequently inexpedient, particularly in the case of mandibular cysts where the removal of the entire wall may expose the mandibular nerve. In such cases the removal of the outer wall of the cyst to the level of the floor of the cavity will suffice to attain the essential object of treatment which is to establish free drainage. The packing should be removed within twenty-four hours and the cavity allowed to drain into the mouth. Subsequent treatment consists in regular irrigation of the cavity. The opening should be kept patent by a vulcanite plug if it shows signs of rapid contraction.

CHAPTER XXII

Tumour Diseases of the Teeth

ODONTOMES

An odontome has been defined by Bland-Sutton as " a tumour composed of dental tissues in varying proportions and different degrees of development; arising from tooth germs or teeth still in the process of growth."

Any unusual swelling in any part of the organism may rightly be termed a tumour, for the word means a " swelling," but it is the custom to restrict the term to those new growths (neoplasms) which are not the result of inflammatory processes or hypoplasia; are atypical in their manner of growth; serve no function; and arise from causes of which we are at present ignorant.

In the excellent report on odontomes, issued by the British Dental Association, the authors have included certain malformations of the teeth which seem to belong to the category of monstrosities or abnormalities. There is some evidence that these abnormalities may be related to tumour formation, and this point is referred to in the description given of composite odontomes on p. 638. Until we possess a fuller knowledge of the genesis of abnormalities of the teeth and odontomes it seems advisable to apply the term odontome only to those abnormal conditions of the teeth which correspond clinically to our present accepted definition of tumours.

The most satisfactory classification of odontomes is that based on the parts of the tooth germ from which the odontome originates —a method first suggested by Bland-Sutton.

(A) ODONTOMES ARISING FROM THE TISSUES OF THE ENAMEL ORGAN

(1) Epithelial Odontomes

According to Bland-Sutton, " These tumours occur, as a rule, in the mandible, but they have been observed in the maxilla. They have a fairly firm capsule, and in section display a congeries of cysts of various shapes and sizes; but the loculi rarely exceed 2 cm.

in diameter. The cysts are separated by thin fibrous septa, sometimes ossified. The cavities contain brown fluid. The growing portions of the tumour have a reddish tint" (figs. 752 and 753).

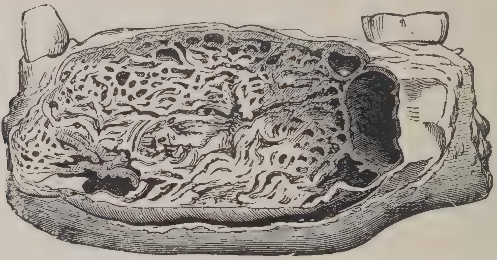


Fig. 752.—"Section of an epithelial odontome showing honeycombed appearance" (Bland Sutton).

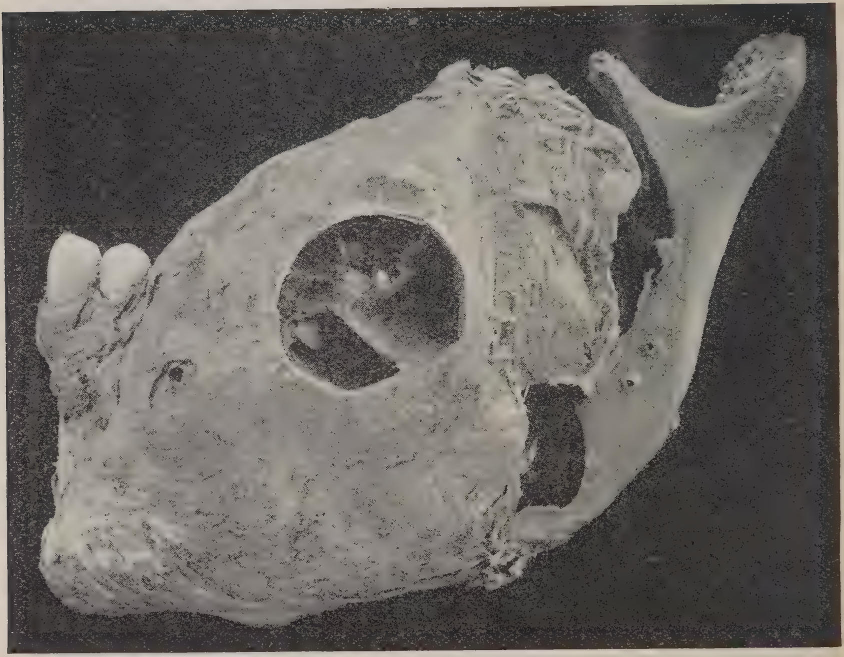


Fig. 753.[1]—Left half of the mandible affected by an epithelial odontome, No. 2198, Museum Royal College of Surgeons of England.

"Histologically, an epithelial odontome consists of branching and anastomosing columns of epithelium, portions of which form alveoli. The cells lining the alveoli vary in shape; those of the

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[1] From the Report on Odontomes (*Brit. Dent. Assoc.*).

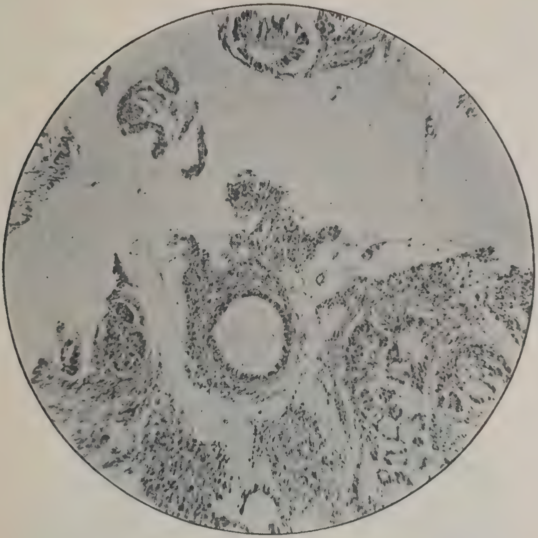


FIG. 754.—From an epithelial odontome described by W. W. James, *Proc. Roy. Soc. Med.*, vol. ii (Odonto. Sec.), p. 171.

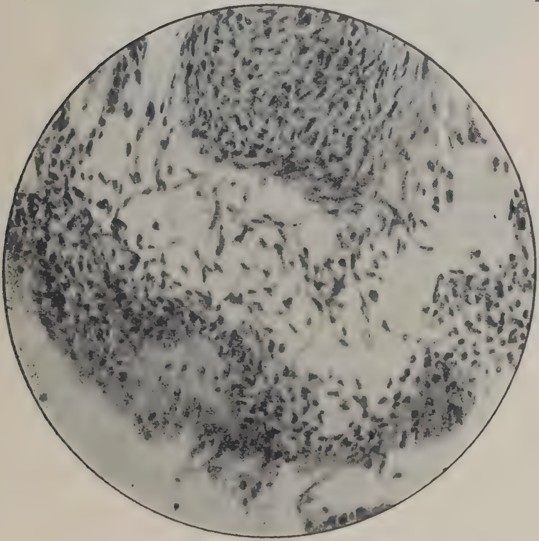


FIG. 755.—Section showing cells resembling those of the stellate reticulum of the enamel organ. From an epithelial odontome described by W. W James, *Proc. Roy. Soc. Med.*, vol. ii (Odonto. Sec.), p. 171.

outer layer are columnar; the central cells degenerate and give rise to tissue resembling the stellate reticulum of an enamel organ." Sections from an epithelial odontome are shown in figs. 754 to 756.

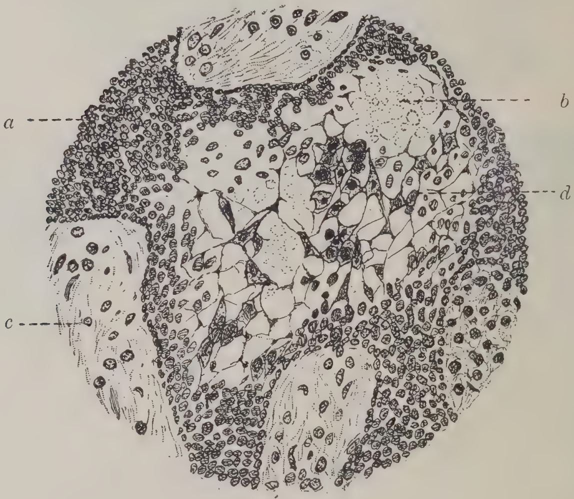
The exact origin of the epithelial odontome is not known. It may arise from:—

(*a*) An aberration of an enamel organ.

(*b*) An ingrowth of the epithelium of the gum.

(*c*) The "débris paradentaires" of Malassez.

The growth of an epithelial odontome is often insidious and slow in progress, extending in some cases over a period of twenty years.



× 250.

FIG. 756.—Epithelial cells in epithelial odontome breaking down and forming commencement of a cyst (from a drawing by A. Hopewell-Smith). *a*, epithelium; *b*, colloid appearance of earliest contents of cyst; *c*, mesoblastic tissue which constitutes the mass of the odontome; *d*, stellate character of epithelial cells.

"A growth in the neighbourhood of the alveolar process is noticed, the swelling gradually increases, and the tooth overlying becomes loosened and may fall out. Not infrequently a glairy fluid is discharged from a vacant alveolus, the orifice of which may become ulcerated." The surface of the swelling is often lobulated, and the condition may therefore be mistaken for a myeloma.

The cases recorded indicate that epithelial odontomes are more common in females than in males. They are usually met with in early adult life, but they have been found in young children and also in old people and apparently may occur at any time of life.

The **treatment** consists in opening up the cyst, care being taken to break down all the loculi and thoroughly remove the cyst wall. Should the growth return, free excision must be resorted to.

Eve[1] considers that some of the tumours described as spheroidal or columnar-celled carcinoma should be classified as epithelial odontomes. He records the case of a tumour of seven weeks' growth which sprang from the alveolar process between the maxillary first incisors. The patient was a boy, aged eleven years. The growth was entirely confined to the alveolar process and did not extend either to the inferior meatus or the maxillary sinus. The microscopical characters of the growth are shown in figs. 757 and 758.

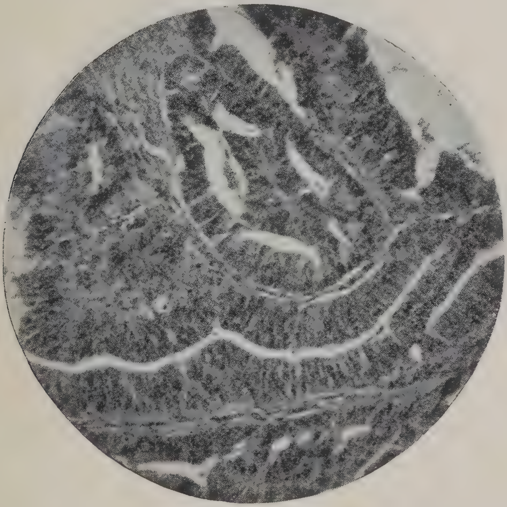


FIG. 757.—(High power). Growth from alveolar process of maxilla, composed of rounded and elongated spaces lined with columnar epithelium. (Eve.)

"Fig. 757, from the centre of the tumour, shows columnar cells, arranged in rounded masses or in tubulous columns with a central space formed by degeneration of the central cells."

"Fig. 758, taken vertically through the gum, shows the columnar-celled growth beneath, but entirely distinct from the epithelium of the gum."

All multilocular cystic tumours must not be regarded as epithelial odontomes. In Bland-Sutton's opinion many of these tumours are endotheliomas.

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[1] "The Pathology and Treatment of Tumours of the Jaws," *Brit. Med. Journ.*, June 29, 1907.

(2) Composite Odontomes

Composite odontomes consist of a collection of denticles which may be separate the one from the other, or may be fused together into an irregularly-shaped calcified mass.

(a) *Composite Odontomes in which the Denticles are separate*

An example of this variety of odontome was recorded by G. Harborow[1] in a boy aged four years. A swelling in the region of the mandibular right incisors, which had been noticed by the parents at the age of eight months, gradually increased in size, and, when seen, extended from the symphysis to the canine and from the gum margins to the bottom of the sulcus between the gum and the cheek. All the teeth were present. An operation was performed, and it was then noted that there was no embracing capsule or lining membrane, each denticle being firmly attached to the posterior wall of the bone by its own capsule. There was no cyst cavity. The permanent teeth erupted, and it is therefore reasonable to assume that the odontome arose in connection with the enamel organs of supernumerary teeth.

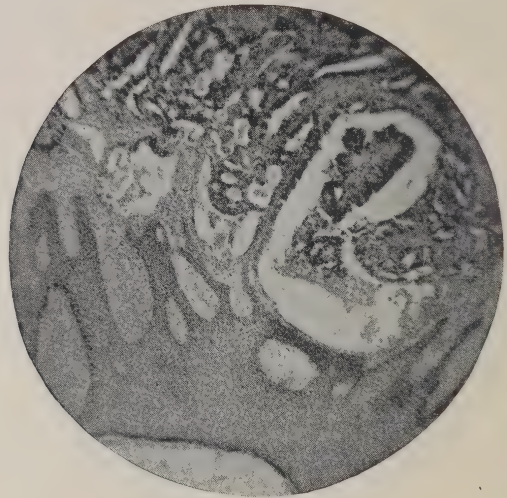

FIG. 758.—(Low power). This section is taken vertically through the gum; beneath this, and distinct from it, is the columnar-celled growth undergoing cystic degeneration. (Eve.)

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[1] *Proc. Roy. Soc. Med.*, vol. xv (Odonto. Sec.), p. 8.

A histological examination made by J. H. Mummery showed that the numerous denticles were in varying stages of development. The sheath of Hertwig was present, also partially formed enamel, and at one margin of the tumour a developing tooth was projecting from the surface showing an imperfect enamel organ and calcified enamel and dentine. In association with one of the denticles there was a complete fibrous capsule in which were scattered epithelial strands and larger masses of epithelial cells.

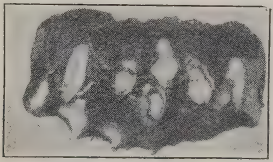

Fig. 759.—Photograph of a composite odontome.
From "The Surgery of Oral Diseases and Malformations," by G. V. Brown.

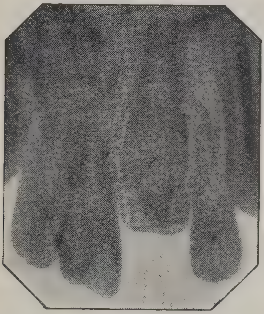

Fig. 760.—Radiogram showing the odontome in position.
From *Proc. Roy. Soc. Med.* Paper by A. H. Johnson.

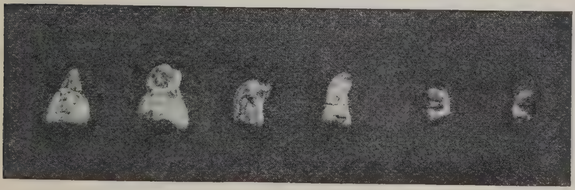

Fig. 761.—Denticles removed from the odontome shown in fig. 760.
From *Proc. Roy. Soc. Med.* Paper by A. H. Johnson.

In fig. 759 is shown a photograph of this variety of odontome which is said to have contained eleven teeth huddled together in a fibrous capsule.

The majority of cases of this variety of odontome are associated with cystic formation. The odontome shown in figs. 760 and 761 was composed of six denticles, and at the operation there was a trace of cystic fluid.

Increase in the formation of cystic fluid leads to a gradual separation of the denticles and a thickening of the surrounding capsule, and gives rise to the condition usually known as "compound follicular odontome."

The first case of this variety was reported in the *Trans. Odonto. Soc.* (vol. iii, p. 282, old series). The patient was a female, aged 27; the cyst developed in the right maxilla, and was first noticed at the age of 12. The first molar, the two premolars, and the canine were absent. When first seen, suppuration had supervened and probably some of the calcified contents of the cyst had been lost. Twenty-eight denticles were removed—nine were tiny single teeth, each perfect in itself, with conical roots and crowns tipped with enamel. Six masses were built up of adherent single teeth, while the remaining denticles were exceedingly small.

In another case[1] two of the fragments were fairly well formed teeth, and to one of the fragments bone, similar to that of the alveolar process, was attached. Denticles from three cases of composite odontomes are shown in fig. 762.

The case described by Bland-Sutton in the thar[2] has thrown light upon the nature of these interesting cysts. He describes the condition he found as follows: "Each antrum contained, in fact, a cyst with dense thick walls. The outer shell was of bone, lined with thick fibrous tissue. The interior was occupied with denticles, fragments of cementum and bone of varying shapes and sizes, amounting to nearly three hundred. Those in the middle of the cyst were glued together by thick pus mixed with hay and chaff, while the peripheral fragments were embedded in fibrous tissue or sprouted from the cyst wall" (fig. 763).

(b) *Composite Odontomes in which the Denticles are fused together*

These odontomes consist of irregularly-shaped calcified masses and are composed of enamel, dentine and cement which are apparently disposed in no definite arrangement. They may occur

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[1] *Trans. Odonto. Soc.* (Old Series), vol. iii, p. 366.

[2] *Trans. Odonto. Soc.*, vol. xx, p. 185

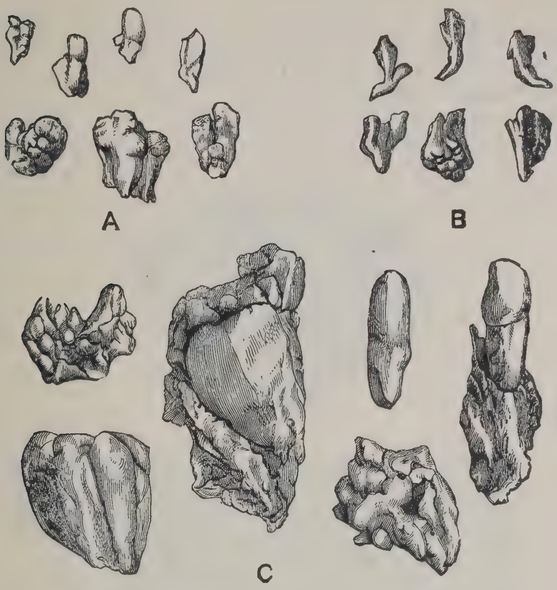

FIG. 762.[1]—Denticles from composite odontomes.

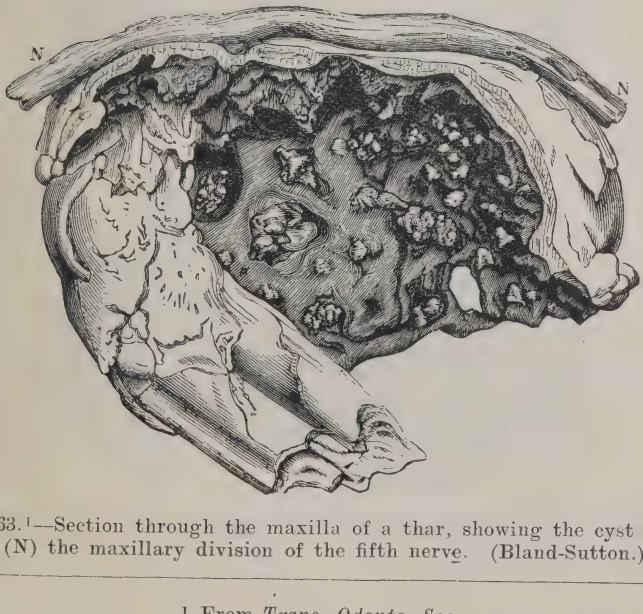

FIG. 763.[1]—Section through the maxilla of a thar, showing the cyst *in situ*. (N) the maxillary division of the fifth nerve. (Bland-Sutton.)

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[1] From *Trans. Odonto. Soc.*

in either the maxilla or the mandible. They vary in size and shape and in the arrangement of their tissues. In the one shown in figs. 764 and 765 recorded by Heath,[1] the measurements were 1½ in. antero-posteriorly, 1 in. transversely, and 1¼ in. from above downwards. The weight was 315 gr.

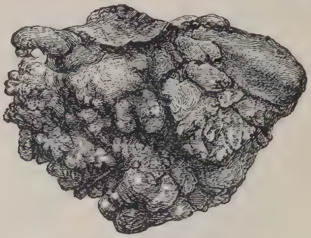

Fig. 764.[2]

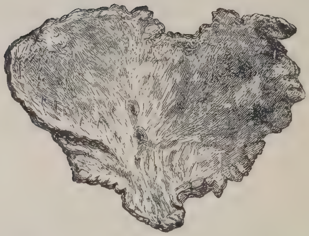

Fig. 765.—Section of odontome shown in fig. 764.

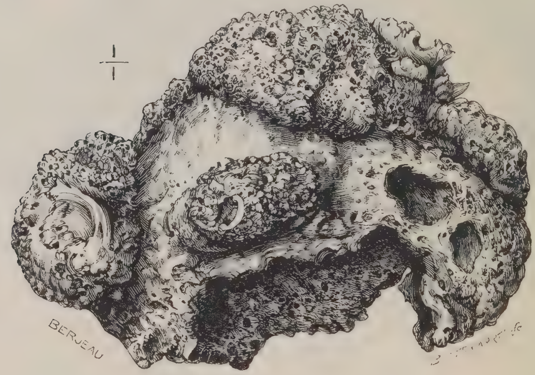

Fig. 766.[3] (Bland-Sutton.)

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[1] "Injuries and Diseases of the Jaws." Fourth Edition, p. 319.

[2] From "Injuries and Diseases of the Jaws," by C. Heath.

[3] From "Tumours, Innocent and Malignant," by Bland-Sutton.

A remarkable example of composite odontome is shown in fig. 766. It was removed from a Kaffir boy, aged 14, and occupied the position of the left premolars and molars. In the mass, which is composed of dentine imperfectly calcified and very irregular, there seems to be some cement but no enamel. The weight of the growth was 59 grm. or 885 gr., and the size 70 mm. by 62 mm. by 39 mm. The parents first noticed a swelling when the boy was 6 months old, but they paid no attention to the growth.

In fig. 767 an illustration is given of a maxillary right first incisor, on the palatal aspect of which is a cauliflower-like mass of tooth issue. This mass, although not an integral part of the root of the tooth, has nevertheless grown, as it were, around the root, so that when the odontome is separated from the tooth a marked groove is seen on the former corresponding to the shape of the palatal surface of the root. An examination of the specimen shows that the odontome covered not only the root, but also the upper half of the palatal aspect of the crown of the tooth. The occlusal surface of the tooth shows no signs of attrition and this suggests that the tooth did not erupt into correct position; the root of the tooth shows signs of absorption around the apical portion. The fact that the odontome has grown around the root which is fully formed seems to indicate that the odontome was formed after the growth of the root. A section of the specimen shows that it is composed of enamel, with cemental-like tissue; a few dentinal tubes are seen in places. The odontome must therefore be regarded as belonging to the composite class.

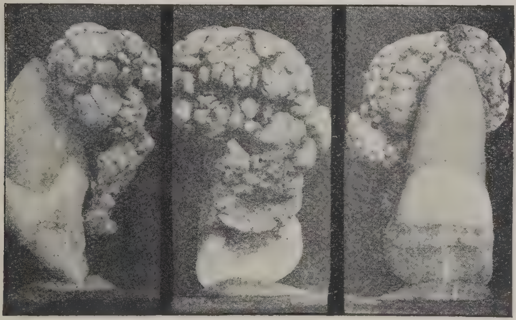

Fig. 767.[1]

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[1] From *Trans. Odonto. Soc.*

It is interesting to examine this specimen in the light of knowledge gained from other specimens in order to determine whether such tumours are in any way related to supernumerary teeth. In the first place we find, in the region of the premaxillæ, the ordinary supernumerary tooth appearing in the form of a peg-shaped or an irregularly shaped incisor. Next, we have a stage where, in place of the single tooth, several well-formed denticles are present. Such a specimen has been figured and described by M. H. Cryer. In the region posterior to the maxillary left first incisor was a mass of tooth tissue composed of five separate denticles, each denticle being composed of enamel, dentine and cement. Another specimen belonging to Cryer takes us a step further. Here a tumour had displaced the first incisor, the denticles contained in the tumour numbered thirty-five and were in some cases single and in others fused together. In a further stage, we have numerous denticles fused together so as to form an irregular mass of tooth tissue, and an excellent example of this condition was figured by Bland-Sutton.[1] The tooth (fig. 768), removed from a lad, aged 19, was situated in front of the right first premolar and had caused displacement of the canine and second incisor. The root of the tooth was not formed and the crown showed nine distinct eminences. Bland-Sutton, in referring to this case, says that "the appearance of the specimen is as though a group of supernumerary teeth had become confluent"; also, "It is easy to imagine that if the cusps of this odontome had remained distinct and each had been separately erupted they would have been called supernumerary teeth. Indeed, many of the cusps can be easily detached from the main mass." On the other hand, if the denticles had remained separate and a cyst had developed in connection with them we should have the condition known as "compound follicular cyst." Thus "this strange specimen," to use Bland-Sutton's words, "serves to

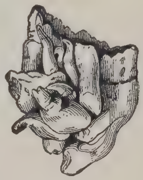

FIG. 768.

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[1] *Dental Record*, vol. ix, p. 435.

bridge the gap between compound follicular cysts and composite odontomes."

In the specimen shown in fig. 767, the stage of complexity seems to have advanced one step further, and in place of a tendency towards well-formed denticles we have more or less defined excrescences of enamel embedded, as it were, in a matrix of tissue cemental-like in character.

The odontome is not always the aberration of one tooth germ, for in some examples there is evidence that at least two teeth germs were implicated in the growth.

An idea of the microscopical character of some of these odontomes can be formed from figs. 769 to 772.

In figs. 769 and 770[1] the section is composed of alternate layers of enamel and dentine which are seen to run for the most part in a vertical direction. Here and there spaces exist, some being circular, others quite irregular in outline; the majority of these spaces are lined with enamel, the calcification of which is usually perfect or almost perfect. Patches of enamel can also be seen dotted about the section. The arrangement of the structures in this loose fashion renders the tissue exceedingly friable.

In figs. 771 and 772[2] the structure is " complex and very mixed; in parts, labyrinthine or folded in appearance; in others, osteodentinal." The main body of this odontome was dentine, though of a very irregular character, full of openings and canals, with patches and crescents of enamel in all kinds of positions scattered through it. There was very little cement, but a few lacunæ occurred in parts."

Signs and Symptoms.—An odontome is covered by a capsule from which it derives its nourishment, and, as it gives rise to no painful symptoms during the period of growth, its presence often passes unnoticed. Composite odontomes are said to pass through an eruptive stage similar to the eruption of teeth. From one cause or another some portion of the capsule becomes disintegrated; suppuration then takes place, and the odontome under these conditions is likely to be mistaken for a more serious disease of the jaw.

Composite odontomes are rare in the lower animals. One shown in fig. 773, from an Abyssinian buffalo, occupied the position of the mandibular first molar. In another case recorded, from a Cape buffalo, a large cyst had developed in the maxilla in association with the odontome.

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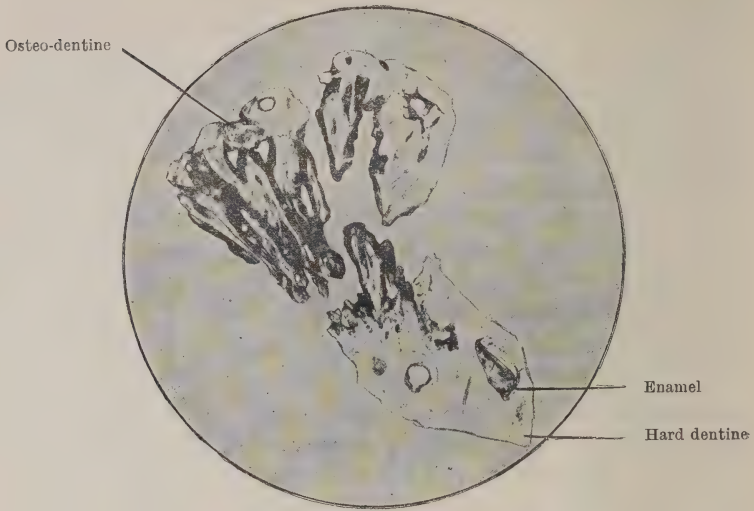
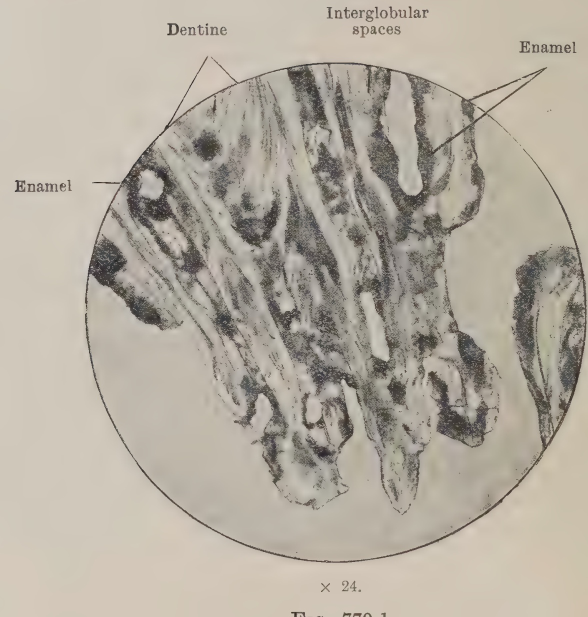
[1] Recorded by J. Lewin Payne (*Brit. Dent. Journ.*, June 15, 1904, vol. xxv, p. 402).

[2] Recorded by J. J. Andrews (*Trans. Odonto. Soc.*), vol. xxvii, p. 42.



× 6.

Fig. 769.[1]



× 24.

Fig. 770.[1]

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[1] From *Brit. Dent. Journ.*

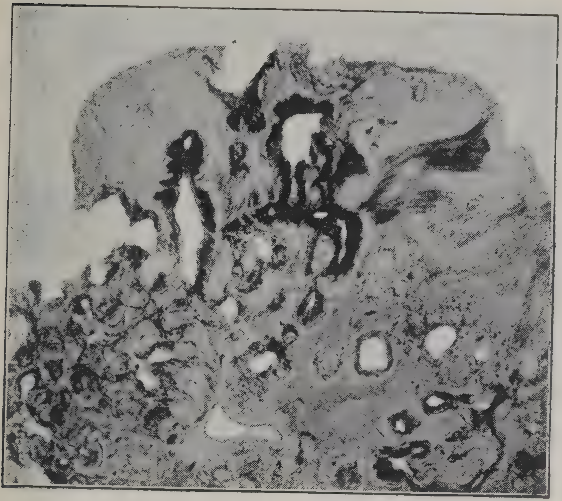

FIG. 771.[1]—× 12.

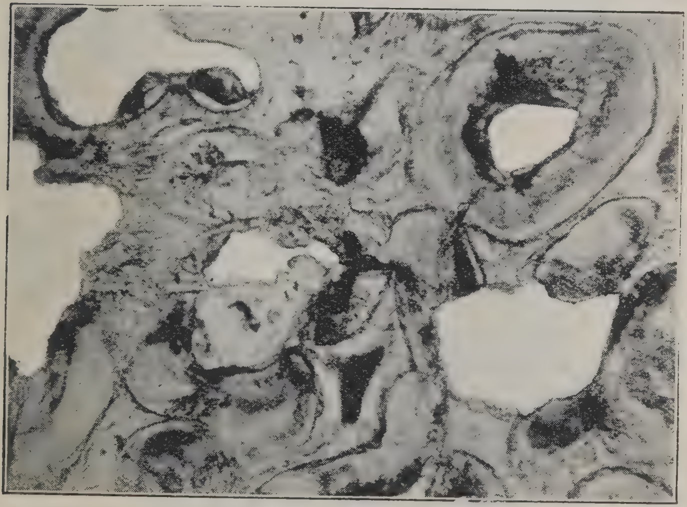

FIG. 772.[1]—× 80.

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[1] From *Trans. Odonto. Soc.*

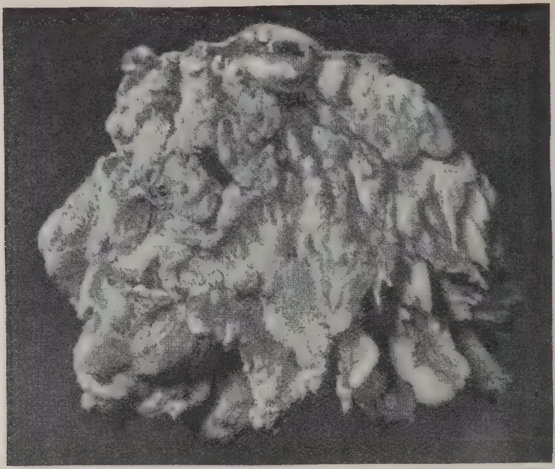

Fig. 773.—Composite odontome from the mandible of an Abyssinian buffalo. (*Bos caffer æquinatialis*).

Eve has described a group of tumours which he has classed as Composite Embryoplastic Odontomes. Clinically these tumours resemble sarcomata. Of the four cases which he has recorded three occurred in the mandible and one in the maxilla. When the tumours first appeared the patients were aged 21, 33, 53 and 55

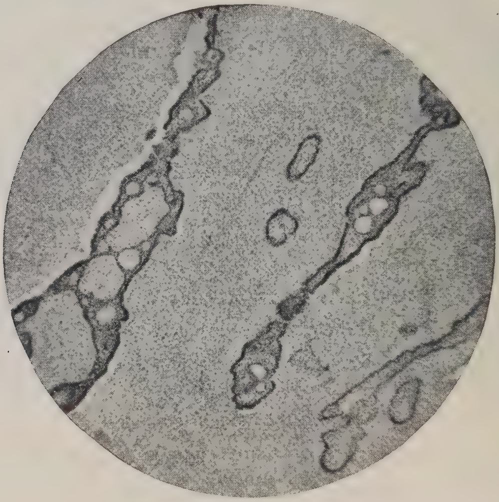

Fig. 774.—(Low power.) Composite embryoplastic odontome showing strands of enamel epithelium lying in a sarcomatous ground substance. The strands enclose small cysts and areas of stroma.

respectively. In one case the growth had continued for eleven years, while in the one recorded in the maxilla the swelling had only been noticed for four months. Microscopically the tumours were composed of irregularly shaped masses and columns of enamel epithelium embedded in a sarcomatous stroma, figs. 774 and 775.

Eve[1] says: "The dental character of these tumours cannot be doubted, owing to the characteristic appearance and arrangement of the epithelium."

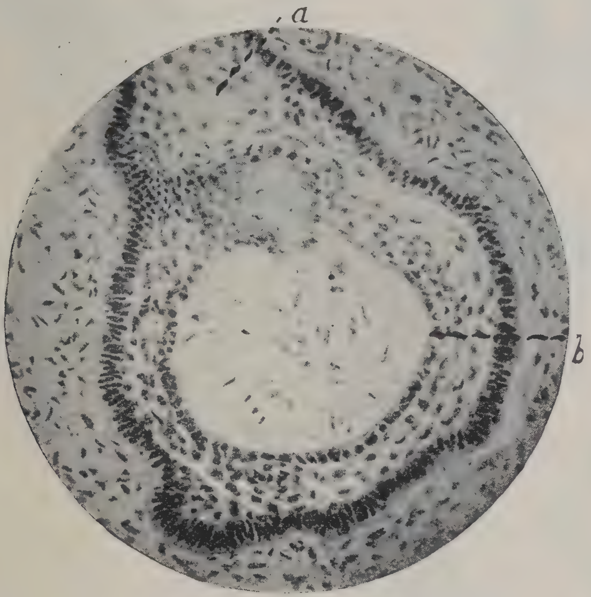

FIG. 775.—Part of section shown in fig. 774, but under a higher objective. The figure shows a rounded strand of enamel epithelium, lined externally with columnar cells. The intermediate layer exhibits a reticulum (*a*). At its centre the strand is penetrated by a round area of stroma (*b*).

(B) ODONTOMES ARISING IN CONNECTION WITH THE TOOTH FOLLICLE

(1) Follicular Cysts (Dentigerous Cysts)

If a section of a jaw is made to include a tooth about to erupt, it will be noticed that the tooth is surrounded by a membrane completely enclosed in a capsule of bone. In the follicular cyst fluid collects between the bony capsule and the tooth. As the fluid increases in quantity, the bony surroundings of the tooth are absorbed, and at the same time fresh bone is deposited on the outer side of the jaw (figs. 776 and 777). In this way the jaw may

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[1] *Brit. Med. Journ.*, June 29, 1907.

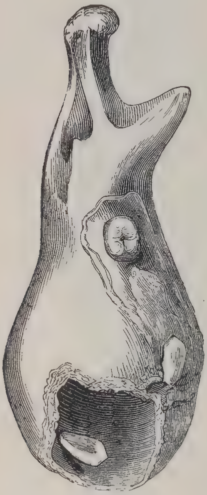

Fig. 776.

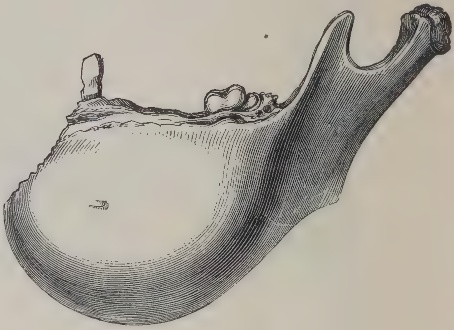

Fig. 777.

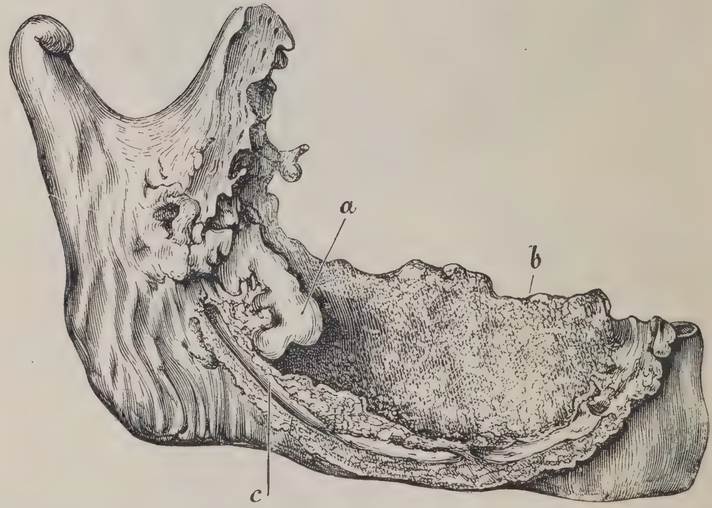

Fig. 778.—(*a*) tooth; (*b*) inner wall of cyst; (*c*) canal for mandibular nerve. (From Heath.)

become enormously expanded as shown in fig. 778. In the maxilla the cyst may encroach upon the maxillary sinus (fig. 782).

This type of cyst was described by earlier writers as a dentigerous cyst; later on the term follicular odontome was introduced. The latter term was adopted on the supposition that the cysts were due to a collection of fluid between the follicle and the tooth. Recent investigations have shown that these cysts arise within the follicle itself, and it would therefore seem that the term follicular cyst more correctly describes the nature of these cysts.

Follicular cysts are mostly found in young adults, but they may occur at any age. They are about equally distributed between the maxilla and the mandible, and between males and females. They may arise in connection with any tooth, but in the majority of cases are associated with the canine. Occasionally they arise in connection with a supernumerary tooth or with a deciduous tooth.

Pathology.—J. H. Mummery[1] has shown that the coronal portion of the follicle includes a considerable amount of epithelial tissue. For convenience of description he divides this portion of the follicle into three parts. "On the outer side there is a layer of connective tissue fibres arranged in parallel bands transversely to the long axis of the follicle, open in texture, and containing connective tissue cells and blood-vessels. In this part there are only a few isolated masses of epithelial cells. Beneath, and from the fibres of this outer layer, strong wavy connective tissue fibres pass into the follicle chiefly in a longitudinal direction, forming a network of connective tissue in its substance and everywhere enclosing islands and strands of epithelium. This forms the middle layer. At the centre and sides of the coronal part of the follicle—the inner third, to one half in some situations, consists almost entirely of epithelial cells with narrow dividing bundles of connective tissue and numerous connective tissue cells, and forms a thick lining to the inner margin of the follicle and is intimately blended with the remaining cell layers of the enamel organ. In this portion the epithelial cells appear to be in all stages of degeneration—they are very large and irregular in shape with inconspicuous or multiple nuclei. Near the free inner surface they are arranged in many layers, and the prickles or intercellular bridges are very conspicuous, an indication of degeneration or keratinization, and small concentric arrangements or cell nests are frequently seen and cells with multiple nuclei undergoing amitotic division, another sign of degeneration." That the follicular cyst has its origin in these epithelial masses is shown by the following case. A cyst in connection with a maxillary first incisor in a child aged seven years and six months; the incomplete root was firmly embedded within the

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[1] *Brit. Dent. Journ.*, vol xli, p. 1.

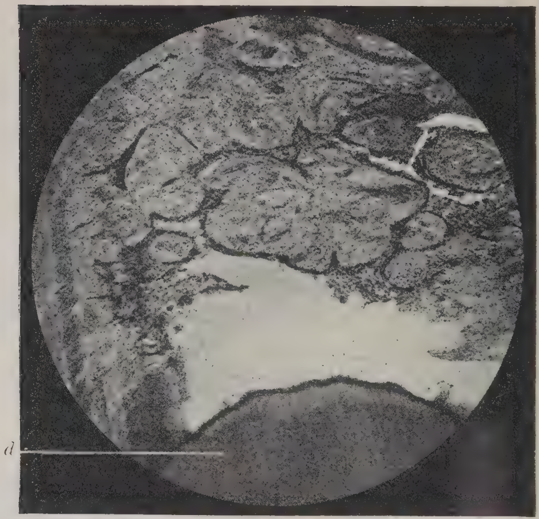

Fig. 779.[1]—Follicular cyst. Proliferation of epithelium and connective tissue over the crown of the involved tooth (the enamel has been decalcified); *d*, dentine at point of attachment of the follicle. × 50. (Mummery.)

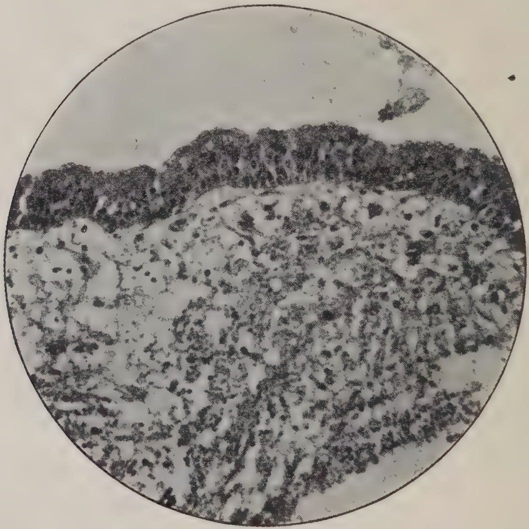

Fig. 780.[2]—Section of cyst wall showing the epithelial lining.

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[1] From *Brit. Dent. Journ.*

[2] From *Proc. Roy. Soc. Med.*

cyst which tightly enclosed the tooth at the neck; the lingual aspect of the crown was in close contact with the cyst; sections made through the tooth in a longitudinal direction showed a marked proliferation of epithelial masses seen in the normal follicle, the epithelium extending deeply and penetrating the connective tissue fibres in all directions fig. 779). The section is taken through the part of the follicle adherent to the enamel; the space in the illustration between the dentine and the follicle was occupied by enamel.

The breaking down of the epithelial cells leads to the formation of a cyst and a fibrous capsule of varying thickness develops around the cystic fluid. Fig 780 is a section through the wall of a follicular cyst showing the lining of epithelium. The epithelial lining cannot always be demonstrated, but this may be because it is destroyed in the process of preparing the section.

A tooth is generally found projecting into a cyst cavity (fig. 781), the roots, frequently only partially formed, being embedded in the cyst wall. Occasionally the tooth lies free in the cavity. Cases are recorded where the tooth lies outside the cyst cavity, but it is an open question whether such cases should properly be classed as follicular cysts (*vide infra*).

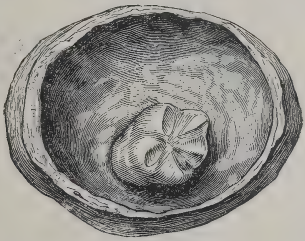

FIG. 781.[1]—A follicular cyst (natural size).

The walls of follicular cysts may contain calcareous material; in rare instances the whole wall may undergo calcification. An example is described by Salter[2] (fig. 782). The cyst had invaded the maxillary sinus and had arisen in connection with a supernumerary tooth.

The fluid of the cyst is generally of a yellowish colour, is viscid in character, epithelial debris are usually present and crystals of cholesterin. Suppuration may occur, a condition more commonly met with in the lower animals.

Cases of multiple cysts have been met with. In a case recorded by Salter, cysts occurred on both sides of the maxilla of a young girl.

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[1] From *Trans. Odonto. Soc.*, vol. xxvi, p. 182.

[2] "Dental Surgery and Pathology," p. 219.

In a case recorded by W. Hern,[1] there were three cysts, two in the maxilla in connection with the second incisors, and one in the mandible around the unerupted left canine.

Pathology.—The view previously held that the cyst was formed by an increase of secretion of fluid between the tooth and the follicle was founded on the assumption that normally a certain amount of fluid was always present in this position; but Mummery has shown that this is not so, the follicle lying in contact with the enamel.

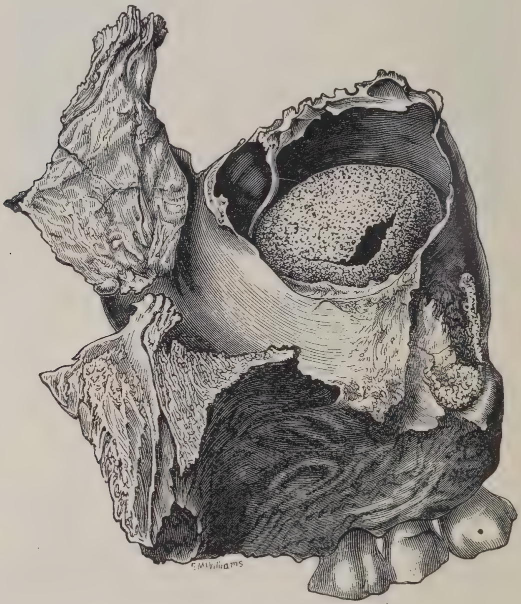

FIG. 782.[2]

It has also been held that the cystic fluid was formed from the stellate reticulum, an argument put forward in support of this view being the supposed absence of Nasymth's membrane from teeth contained in follicular cysts. More careful research has shown that this membrane is often present in the teeth, and its absence in some cases is probably of no significance. Immediately preceding eruption the membrane is attached to the follicle and to the enamel;

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[1] *Trans. Odonto. Soc.*, vol. xxvi, N.S. p. 91.

[2] "Dental Surgery and Pathology," by Salter.

but as the cells become hardened by cornification they separate and become firmly adherent to the enamel. If the cyst starts before cornification these cells probably disappear with other degenerating cells of the cystic follicle.

In a paper contributed to the *Proc. Roy. Soc. Med.*,[1] E. C. Sprawson suggests that follicular cysts are primarily dental cysts and are usually formed in connection with septic deciduous teeth. The cyst by growth and extension in the direction of least resistance eventually meets with and surrounds an adjacent unerupted tooth, gradually enveloping it, at first, to the extent of the crown only, but later by causing absorption of the surrounding bone to its whole extent, and in this way prevents the eruption of the tooth.

It is accepted that dental cysts in connection with permanent teeth often have originated in the so-called "granuloma." Although these root swellings are not found with deciduous teeth, Sprawson maintains that they probably do occur in connection with deciduous teeth and that what happens is that in the process of absorption of these teeth the granuloma is separated and becomes a potential cyst, which by its growth gradually envelops the underlying permanent tooth.

The development of cysts which lie external to the tooth may be explained by the theory propounded by Sprawson, but it is a little difficult on these lines to account for those cysts which occasionally arise in connection with the molars and involve the ramus. It is possible that all follicular cysts do not develop in the same manner.

Signs and Symptoms.—Follicular cysts produce slow-growing swellings, leading in the mandible to an expansion of the walls, while in the maxilla they frequently invade the sinus and may give rise to a distension of its walls. No pain is usually experienced unless suppuration has taken place. Upon manipulation of the swelling, the bony walls will often (but by no means always) yield to pressure and resume their shape as soon as the pressure is removed, the movement producing a curious kind of crepitation which has been termed "crackling." Occasionally, the bony wall does not exist and distinct fluctuation can be obtained. There is usually a history of absence of a tooth in the region of the swelling, and this is an important diagnostic sign.

The *differential diagnosis* from other tumours in the mouth is dealt with in Chapter XXXIII.

Treatment.—Treatment consists in removal. The muco-periosteum covering the cyst wall is first reflected and the bony wall divided and in great part removed. The tumour is then dissected out.

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[1] Odonto. Sec., vol. xv, p. 58.

(2) Fibrous Odontomes

The external parts of the tooth sac are composed of fibrous tissue and if this tissue becomes hypertrophied a fibrous odontome is formed. The nature of these odontomes is shown in fig. 783. Under the microscope, the thickened follicle is found to be composed of fibrous tissue, laminated in character and at times partly ossified. In the lower animals these odontomes are generally symmetrical, and in one case, that of a dasyure, the skeleton was softened by rickets. The presence of rickets in this case may have been an accidental circumstance, but in view of the fact that rickets seems to thicken the membrane which covers growing bone, it is not improbable that *there may be some relation between rickets and this class of odontome.*

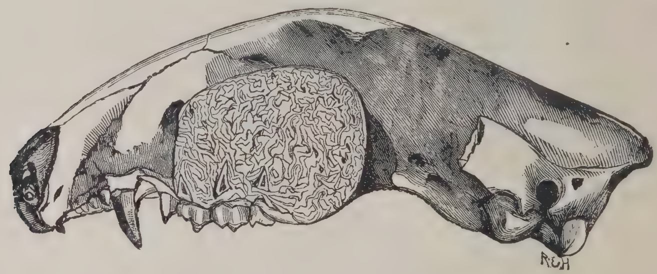

Fig. 783.[1]—Portion of the skull of a dasyure, showing a fibrous odontome in section. The tumour was intimately connected with a molar tooth. (Bland-Sutton.)

Bland-Sutton contends that many of the fibroid and fibro-cellular tumours of the jaw which have been recorded are really examples of this form of odontome.

An odontome of this variety is described by Jordan Lloyd under the name of endosteal fibroma.[2] The patient, a girl aged 8, had a large swelling on the right side of the mandible, extending from the angle of the bone to within an inch of the symphysis. The deciduous and first permanent molars on that side were missing, the former having been extracted. The tumour was exposed by removing the outer plate of bone and was shelled out of its bed without difficulty. It was found to be attached only at its lower and posterior part, and was lying over the first permanent molar which was displaced to the lower border of the mandible. The following is the description of the tumour: "It measured nearly three inches in length, two in depth, and nearly one and a half in thickness. It was of uniform pearly colour and of a regular tough consistence. At its lower and hinder part was a large well-formed permanent molar tooth lying with its crown against the tumour to which it was held in organic connection by a delicate fibrous membrane passing from the outer surface of the tooth roots to the delicate connective tissue capsule which covered the tumour." A microscopical examination showed the growth to be "closely allied to fibrous tissue on the one hand, and to fibrous cartilage on the other, rather nearer the former than the latter."

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[1] From *Trans. Odonto. Soc.*

[2] *Journ. Brit. Dent. Assoc.*, vol. xiv, p. 564.

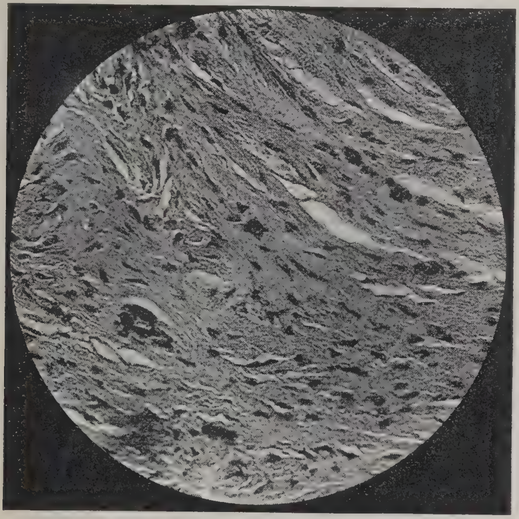

FIG. 784.

From *Proc. Roy. Soc. Med.* Paper by W. H. Dolamore.

A tumour which would seem to belong to this group of odontomes has been recorded by W. H. Dolamore.[1] The growth occupied the position of the maxillary canine which was absent, the opposite tooth being present. The child was three years of age. The radiograms suggested the presence of bony septa. The growth was found to be composed of dense fibrous tissue containing a few fragments of bone (fig. 784).

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[1] *Brit. Dent. Journ.*, vol. xli, p. 1155.

(3) Cemental Odontomes

These odontomes are rare in man but common in horses and ruminants. In man they are usually met with in the region of the mandibular molars and there is at times a definite history of rickets. They are composed of cement, but the structure differs from normal cement, it is non-laminated, is often vascular, and the lacunæ "appear isolated with a quantity of clear or areolar matrix"; Sharpey's fibres are well marked. Cemental odontomes lead to a hard tumour of the jaw, generally painless in the early stages, but later giving rise to pain which is apt to be mistaken for periostitis or necrosis. Fig. 785 is the drawing of a cementome recorded by Forget; the odontome was about the size of a pigeon's egg and came away with a carious molar which he decided to extract before opening the tumour.

The possible association of fibrous odontomes and cementomes with rickets is suggested by a case, recorded by Bland-Sutton, in which a cementome was found in the position of the right mandibular molar of a boy who presented unmistakable evidence of rickets.

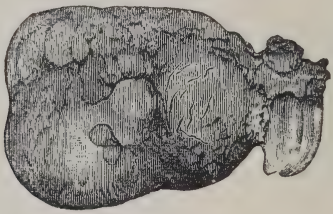

Fig. 785.

J. Ward-Cousins[1] has described a tumour from which he removed a number of fragments composed of cement traversed by irregular vascular canals. The odontome occupied the region of the angle of the mandible on the right side. In this case we seem to have an example of sporadic calcification of the tooth sac.

(4) Osseous Odontomes

In a paper[2] dealing with abnormalities in position of the teeth attention was directed to the presence of bone around the developing tooth, and it was shown by examples of certain animals that this bone was distinct from the bone composing the general structure of the jaw, and was in reality an integral part of the developing tooth. This bone must necessarily be developed from the follicle, and it is conceivable therefore that just as odontomes composed of fibrous tissue or cement may arise from this organ so may a growth composed of osseous tissue.

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[1] *Brit. Med. Journ.*, June 6, 1908.

[2] *Dental Record*, vol. xl, No. 7.

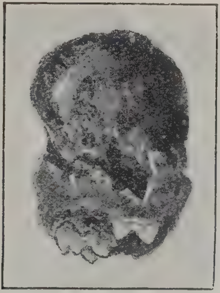

FIG. 786.
From *Brit. Dent. Journ.* Paper by J. H. Mummery and A. T. Pitts.

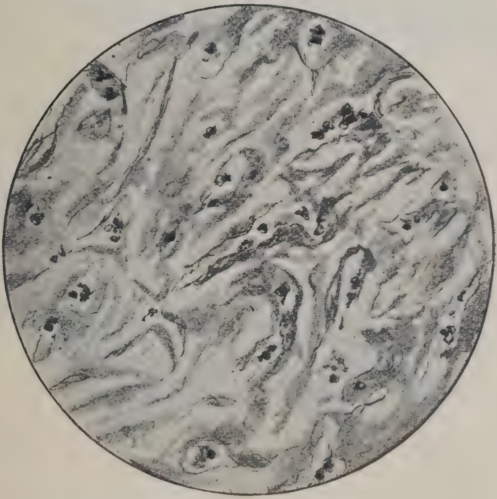

FIG. 787.
From *Brit. Dent. Journ.* Paper by J. H. Mummery and A .T. Pitts.

The odontome (fig. 786) seems to belong to this variety. The odontome consisted of an irregular rounded mass of calcified tissue enveloping completely the roots of the maxillary left deciduous molars. It measured 19 mm. in the antero-posterior diameter and 22 mm. in the transverse diameter. Histological examination showed that the growth consisted of a homogeneous mass of cancellous bone, with in one part a secondary breaking down of the bony tissue accompanied by a low-grade inflammatory process (fig. 787). A section through the pulp chamber (fig. 788) showed at the lower part bony tissue directly continuous with pulp tissue which had undergone fibrotic changes.

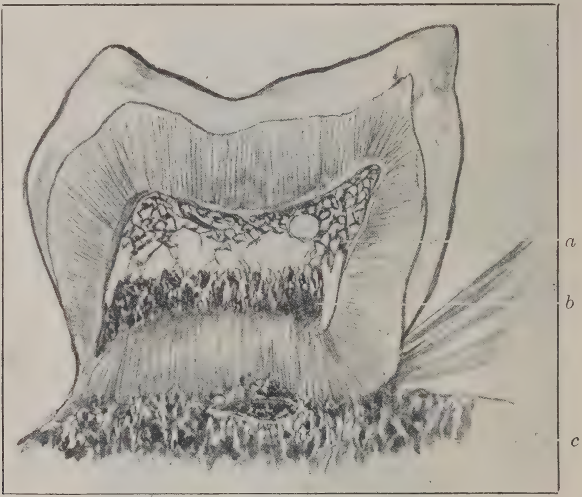

Fig. 788.—Section through the pulp chamber of the first molar; (*a*) degenerated pulp tissue; (*b*) bony tissue at base of the pulp chamber continuous with the pulp; (*c*) cancellous bone of odontome.

From *Brit. Dent. Journ.* Paper by J. H. Mummery and A. T. Pitts.

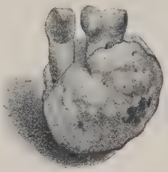

Fig. 789.[1]

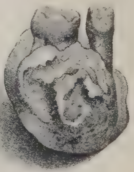

Fig. 790.[1]

An odontome presenting features somewhat similar to those described above is shown in figs. 789 and 790. The patient was a boy, aged 11½; the swelling occurred in the mandible in the region of the first deciduous molar. The tumour was very sensitive to pressure, owing to severe periostitis. After removal, it was found to be composed of a mass of tissue about the size of a large cherry, intimately coalescent with the deciduous canine and first molar. It was covered with a distinct membrane of connective tissue which was closely adherent to the hard tissue. A section of the growth showed that it consisted of hard tissue containing cavities filled with connective tissue and blood-vessels (fig. 791). The distal root of the molar showed considerable absorption.

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[1] Copied by permission from Wedl's "Atlas of Pathology of the Teeth."

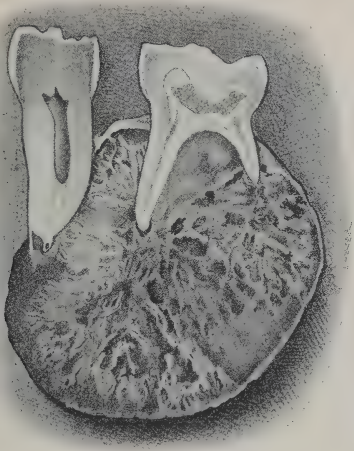

FIG. 791.
Copied by permission from Wedl's "Atlas of Pathology of the Teeth."

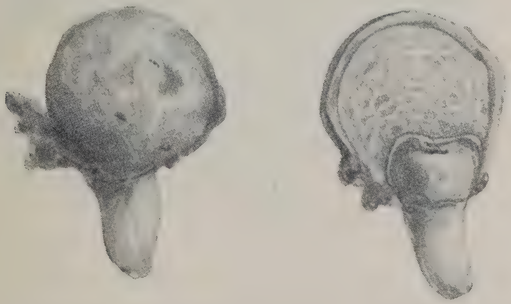

FIG. 792.—Odontome covering the crown of a mandibular molar (half the odontome has been removed to show its relation to the tooth). From a case under D. P. Gabell.

In the odontome, fig. 792, the new growth is limited to the coronal part of the tooth. This odontome was in connection with a mandibular first molar, and the growth which arose around the neck of the tooth covered the entire crown.. Histological examination showed cancellous bone (fig. 793).

A tumour described by Bland-Sutton[1] would also seem to belong to this variety. A swelling which involved the right maxilla developed in a girl, aged eleven years. The teeth were normal in number and shape. The tumour was composed of soft vascular tissue containing pieces of bone to the number of five hundred. On section it was seen that the pieces of bone resembled in character the bone forming the alveolar process.

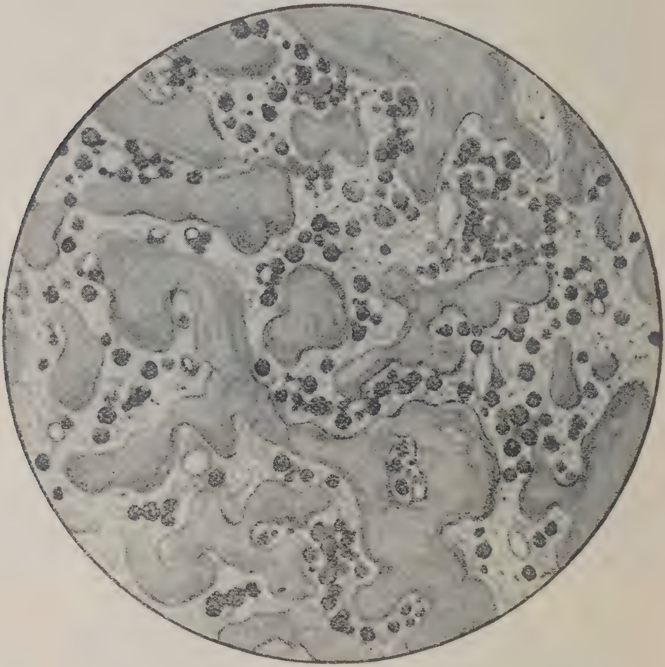

Fig. 793.—Section through the odontome shown in fig. 792. From a drawing by J. H. Mummery.

(5) Sarcomata

The Museum of the Charing Cross Hospital contains a specimen which supports the view that sarcomata may arise in connection with the tooth follicle. This specimen consists of a growth surrounding the crown of a molar tooth and was removed from a child aged five years. It shelled out from the jaw with comparative ease and was surrounded by a definite capsule. Microscopically the tumour was composed of sarcomatous tissue resembling embryonic connective tissue with in places cylindrical groups of epithelial cells.

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[1] *Trans. Odonto. Soc.*, vol. xxxiv, p. 96.

(C) ODONTOMES ARISING IN CONNECTION WITH THE DENTINAL PAPILLA

Radicular Odontomes

Radicular odontomes arise after the completion of the crown and during the formation of the root.

In the lower animals radicular odontomes are frequently found, particularly in animals whose teeth grow from persistent pulps, and are not uncommonly multiple. Bland-Sutton[2] records a case in which he found an odontome at the base of each of the incisor teeth in both maxilla and mandible of a young marmot (fig. 794).

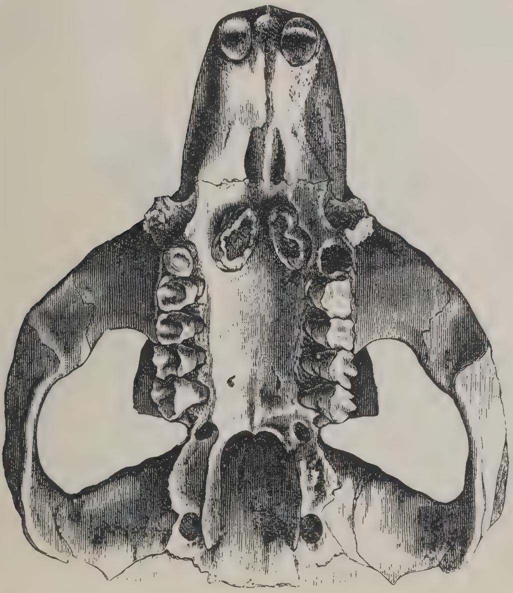

Fig. 794.[1]—Hard palate of marmot. Odontomes connected with the roots of the upper incisor teeth appearing in the hard palate. (Bland-Sutton.)

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[1] From *Trans. Odonto. Soc.*

[2] *Trans. Odonto. Soc.*, vol. xx, p. 65.

The specimen shown in fig. 795 was removed from the maxilla of a man aged 45. The patient had suffered much pain, and a sinus connected with the growth had opened on the face. C. Tomes made a microscopical examination of this specimen, the details of which are to be found in the *Transactions of the Odontological Society*, vol. iv, p. 82.

Another remarkable specimen is in the Museum of the Royal College of Surgeons of England (figs. 796 and 797). This tumour was examined by S. J. Salter.[1] The main mass of the tumour is composed "of a confused mass of bone structure and dentine-structure, arranged around and separating an elaborate vascular network of the same character as that of a dentinal pulp." The upper two-thirds of this mass is covered with a layer of true dentine, the outer portion of the growth being composed of cement.

An odontome of this class, which occurred in the practice of R. Markham, is shown in figs. 798 and 799. The tumour was examined and described by G. Watson.[3] The odontome was in connection with the maxillary left third molar and must have considerably encroached upon the cavity of the sinus. The structure consists of an outer layer of irregularly laminated cement, highly vascular, and containing numerous well-marked lacunæ. The main portion is composed of a narrow band of very intricate convolutions of white and yellow tissue, namely, vaso-dentine and osteo-dentine (fig. 799).

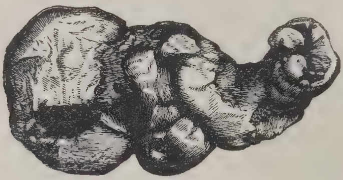

FIG. 795.[2]

The odontome seen in figs. 800 and 801 consists of a large globular swelling about the size of a full-grown acorn, involving one root of a four-rooted maxillary molar. When the tooth was divided, the globular swelling was found to be hollow, and lined with a tissue which presented distinct evidence of having been soft in character. The original pulp chamber is almost entirely filled

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[1] "Dental Pathology and Surgery," by S. J. Salter, p. 125.

[2] From *Trans. Odonto. Soc.*

[3] *Journ. Brit. Dent. Assoc.*, vol. xv, p. 667.

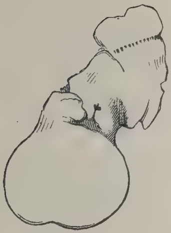

Fig. 796. (Salter.)

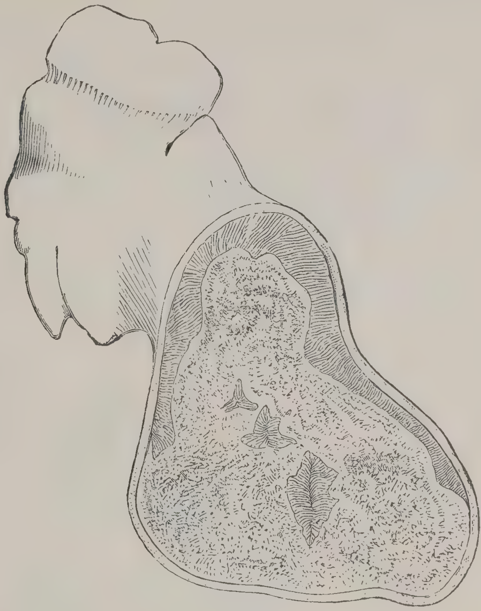

Fig. 797. (Salter.)

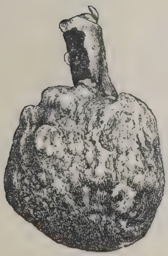

Fig. 798.[1]

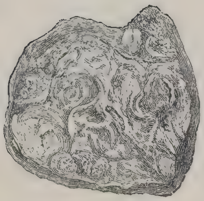

Fig. 799.[1]

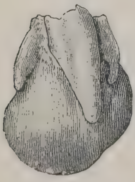

Fig. 800.[1]

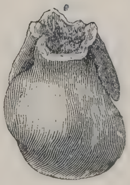

Fig. 801.[1]

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[1] From *Journ. Brit. Dent. Assoc.*

up with a form of secondary dentine (fig. 802, *a*), presenting very little structure beyond a few blood-vessels. The globular swelling itself is bordered by a layer of cement (fig. 802, *b*), the lacunæ being more numerous on the right side of the specimen. This outside cemental layer is bounded internally—

(i) On the right side with dentine fairly regular in type, and continuous with the dentine of the main body of the tooth. The dentinal layer is succeeded by one cemental in character.

(ii) Towards the base, by a dentinal tissue presenting few tubuli.

(iii) To the left, by tissue irregular in type, containing large blood-vessels and irregularly shaped lacunæ, with a few dentinal tubes (fig. 802, *d*), and which, as far as can be ascertained, is continuous with the secondary dentine in the pulp chamber. Inside this layer is a tissue of rather different pattern, but still cemental in character. At one spot (fig. 802, *c*), a transverse section of dentine appears. The aberration seems to have consisted of an overgrowth of one radicle of the pulp, followed by calcification in a direction from without inwards.

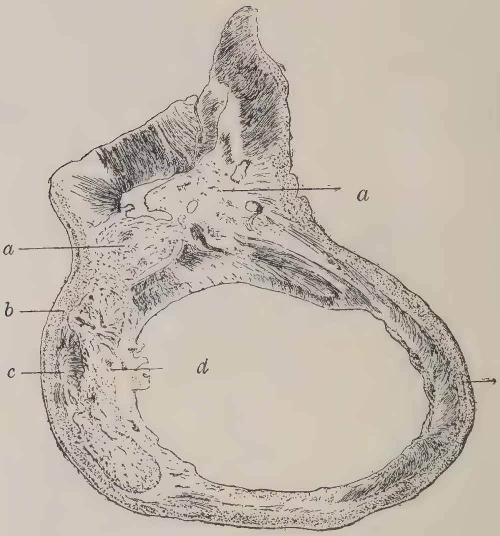

Fig. 802.

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CHAPTER XXIII

The Treatment of Dental Disease in Children

In connection with the treatment of dental disease in children there are a few points which may conveniently be considered under a separate heading. No part of the work of the dental surgeon requires more tact than the treatment of children. Some possess the gift of readily winning the confidence of the young, but this power is not given to all. The operator must constantly bear in mind that he is dealing with children, and that they are interested only in simple topics. Every effort should be made to attract their attention and to avoid giving them pain; but if pain is unavoidable, in no circumstances should they be misled or deceived.

Too great a stress cannot be laid upon the importance of regular and thorough attention to the teeth of children. Dental supervision should commence as soon as the deciduous dentition is complete, and the child should be brought to the dental surgeon at least three times a year for examination. Cavities can then be filled while quite small, with the results that the teeth are more easily saved and the operation is rendered practically painless—a point of no small importance in dealing with children.

In treatment of dental disease in children **the importance of rendering the mouth functional** must be clearly kept in mind. If the mouth is rendered functional it will be kept clean by natural means. The chief causes of a functionless mouth in children are:—

(*a*) Mouth-breathing.

(*b*) Caries of the teeth.

(*a*) **Mouth-breathing** arising from nasal obstruction produces a persistent gingivitis of the gum in the front of the mouth, and predisposes the teeth to caries, especially the incisor teeth. Mouth-breathing is often overlooked, more particularly in children who suffer from intermittent nasal obstruction. *The sign of nasal obstruction which may be regarded as diagnostic consists in a marginal gingivitis limited to the incisor teeth, the gums at the back of the mouth being healthy.*

Too much importance cannot be attached to the proper performance of nasal breathing, and, if there is sufficient naso-pharyngeal trouble present to cause even intermittent mouth-breathing, the trouble must be removed. *Unless a child regularly breathes through the nose it cannot have a healthy mouth.*

(*b*) **Caries of the Teeth.**—It is a matter of common experience that children with carious teeth " bolt their food," thus suspending the function of mastication. *Unless mastication is properly performed the mouth cannot be kept healthy.* It is essential therefore that children's teeth should be rendered capable of performing their function without the least discomfort.

Small cavities, whether in the crown or approximal surfaces, should be filled with amalgam, and special care should be taken to restore the contour of the tooth. Approximal cavities, when they have been opened up and the caries removed, are usually cup-shaped, and the retentive shaping must therefore be carried out by grooving. If the tooth is sensitive, it is sometimes judicious to bring the filling of amalgam against the approximal tooth. With children it is sometimes impossible to remove all the carious dentine from the deeper parts of the cavity, and in such cases the surface of the dentine should be covered with a little powdered nitrate of silver before the filling is inserted.

If the pulp of a tooth is exposed, the better line of treatment, in the majority of cases, is to remove the tooth. This practice may not coincide with that of the majority of practitioners, but the impossibility of thoroughly treating pulp chambers in children, and the fact that suppuration frequently occurs after treatment, incline me to the opinion that, by extraction, the mouth is more likely to be rendered functional. The only instances where conservative treatment is indicated are cases of second deciduous molars in children under the age of six years, that is, where the first permanent molars have not erupted; but even in these cases the teeth should be carefully watched, and, if periodontitis appears, they should be removed.

If it be decided to retain the tooth, the pulp should be removed from the coronal portion of the pulp cavity, and, if possible, from the root canals. Sterilization should then be carried out and the pulp chamber filled with an antiseptic. No attempt should be made to fill the canals, the cavity in the tooth being completed with amalgam.

In a child a tooth with a septic pulp chamber often causes no objective symptoms, but yet is the seat of a slight chronic periodontitis; moreover, the constant absorption of the septic matter from the pulp chamber is liable to cause chronic lymphadenitis.

The cases, however, which demand most serious consideration are those where the majority of the deciduous molars are carious and absolutely unsavable and the child suffers from the effects of sepsis. If the first permanent molars are in position, the best treatment seems to be to remove all the deciduous molars. This treatment has the advantage of removing all sources of sepsis and of isolating the first permanent molars—a point of the greatest importance when the value of these teeth in mastication is considered. As a rule, all opposing teeth, even if free from caries, should be removed. The necessity for removing all opposing teeth will perhaps be made more clear by giving an example. Suppose that in the deciduous dentition the maxillary right molars and the mandibular left molars are unsavable and are removed, then the opposing teeth, namely, the mandibular right and the maxillary left molars, are rendered functionless and are of little use, indeed as functionless teeth they will harbour food debris and so prevent the mouth from being kept naturally clean. The removal of all non-functional deciduous teeth is therefore called for, if the mouth of a child is to be kept clean and healthy.

An objection has been raised that this method of treatment robs the child of masticating power. The answer to this objection is that a carious tooth is usually tender and is avoided in the process of mastication, and that where many carious teeth are present the child "bolts" its food instead of masticating it. In many such cases the lack of function of the first permanent molars can be easily demonstrated by the amount of debris which is present around these teeth. The removal of the carious deciduous teeth allows mastication to be efficiently performed and the masticating power is increased rather than diminished. Another argument advanced against this treatment is that the removal of the deciduous molars allows the first permanent molars to come forward and so cause, in the future, crowding of the anterior teeth. With regard to this argument, it may be pointed out that such travelling forward of the permanent teeth occurs mainly in mouths in which the growth of the jaws is hindered by want of function arising from insufficient mastication or from lack of nasal breathing. From observation—but the point is one on which final judgment is reserved—I am inclined to think that if by removing the deciduous molars the first molars can be rendered functional, the growth of the jaw will be stimulated, and room will be made for the development of the second and third molars. With no forward pressure from the second and third molars, and with the first molars occluding correctly, there will be little, if any, forward movement. But, granting that the suggested treatment by extraction does cause a forward movement and subsequent crowding, the removal of four teeth will easily alleviate the condition. A decision has to be made between the disadvantage arising from the possible loss of four teeth on the one hand and the constant presence of oral sepsis and all the sequelæ on the other. In my opinion the risk of sepsis is by far the greater evil. Still further, it must always be remembered that even if the deciduous molars are retained with the object of preventing a forward movement of the molars, it is quite possible that the removal of teeth to prevent crowding would be necessary, as in mouths such as those in question some interference with the development of the jaws would probably have taken place.

Cases are frequently seen in which caries has progressed rapidly in the first permanent molars to the extent of involving the pulp cavities before the formation of the roots is complete. Such teeth should be removed as they cannot be satisfactorily treated by conservative operations and, if left untreated, they become the foci of infection.

A detailed account of a few cases will serve to illustrate the value of this method of treatment where a child is suffering from dental sepsis.

A girl, aged 4 years 6 months, when first seen was suffering from gastro-intestinal trouble. The teeth removed were: $\dfrac{\mathrm{d\ c\ b\ a} \mid \mathrm{a\ b\ c\ d}}{\mathrm{e\ d} \qquad \mid \qquad \mathrm{d\ e}}$ The $\mathrm{e} \mid \mathrm{e}$ were not carious and were retained until the $\underline{6\ \ 6}$ erupted. The gastro-intestinal trouble cleared up and within four months the child increased in weight from 2st. 4lb. to 2st. 8lb. The normal weight should have been about 2st. 8lb., and the normal increase in four months about 1½ lb.

The rapid increase in weight which follows the extraction is at times very marked. For example, in the case of a boy, aged 10 years 2 months, who was suffering from "glands," it was found advisable to remove $\dfrac{\mathrm{e\ d\ c} \mid \mathrm{c\ d\ e}}{\mathrm{e\ \ \ c} \mid \mathrm{c\ d\ e}}$ In four months his weight increased 5lb., viz., from 4st. 6lb. to 4st. 11lb. The normal weight should have been about 4st. 11½lb., and the normal increase in four months about 2lb.

The following case also illustrates the marked improvement in weight which follows the removal of septic teeth: A boy, aged 6 years 6 months, suffering from marked oral sepsis, enlarged glands in the neck, and gastro-intestinal trouble, was seen on November 28. He was weak and debilitated in appearance, with dark rings under his eyes. He weighed 2st. 12lb. The following teeth were removed: $\dfrac{\mathrm{d\ \ b\ a} \mid \mathrm{a\ b\ \ d}}{\mathrm{e\ d\ b\ a} \mid \mathrm{a\ b\ d\ e}}$ The first permanent molars had just pierced the gum, and the $\mathrm{e} \mid \mathrm{e}$, the pulps of which were not exposed or septic, were retained until the $\underline{6 \quad 6}$ had completely erupted. He was seen again seven weeks later, when his weight was 3st. 3½lb., or a gain of 5½ lb. in about seven weeks. The glands of the neck were considerably smaller, he had lost the dark rings under his eyes, and his appetite and general health had increasingly improved.

A boy, aged 7 years 4 months, stated always to have indigestion. The following teeth were removed: $\begin{array}{c|c} 6\ e\ d\ c & c\ d\ e\ 6 \\ \hline 6\ e\ d\ c & c\ d\ e\ 6 \end{array}$. His weight was 3st. 2½lb. Two months later his weight had increased by 2½lb. to 3st. 5lb., and all symptoms of gastro-intestinal trouble had ceased. The average weight of a boy of this age would be about 3st. 9½lb., and the normal increase in two months would be only a little under 1lb.

Increase in weight after extraction does not always occur, and in a few cases there is a slight reduction in weight, but this is frequently traceable to the presence of sepsis in other parts, for example, in the tonsils or the naso-pharynx, as shown by the following case:—

A child, aged 7 years 6 months, suffering from defective teeth, tonsils and adenoids, was seen on February 23, when the following teeth were removed: $\begin{array}{c|c} 6\ e\ d\ c & c\ d\ e\ 6 \\ \hline 6\ e\ d\ & \ d\ e\ 6 \end{array}$. The tonsils and adenoids were removed on May 3. The child's weights are given below:—

	st.	lb.	oz.
February 23	3	10	8
March 24	3	9	12
May 25	3	9	12
July 26	3	10	12
October 15	4	0	6

In this case the improvement in weight and general health did not follow extraction until other sources of sepsis had been removed.

The cases quoted afford sufficient evidence that the loss of masticating power does not interfere with the general health of a child, but increases its powers of metabolism by removing a source of sepsis.

The effect of early removal of the teeth on the dental arches is shown in the three following cases:—

The models shown in fig. 803 are from the mouth of a child from whom, at the age of 4 years, all the deciduous teeth were removed with the exception of the maxillary canines.

In the case shown in fig. 804 the deciduous molars were removed at the age of 8. The eruption of the premolars caused a slightly crowded condition which was remedied by the extraction of the second premolars. There is here no evidence that a crowded arrangement of the teeth would have been avoided by the retention of the deciduous molars; a line of treatment which produced a clean mouth for four years with, admittedly, some risk of crowding, which is not however difficult to remedy, seems strongly to recommend itself as against a septic mouth and possibly the avoidance of crowding.

An example of a case in which the first permanent molars and the deciduous molars were removed at the age of nine years is shown in fig. 805.

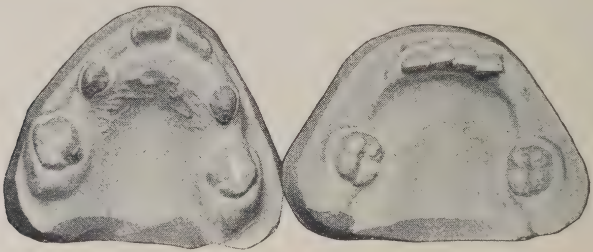

Fig. 803.[1]

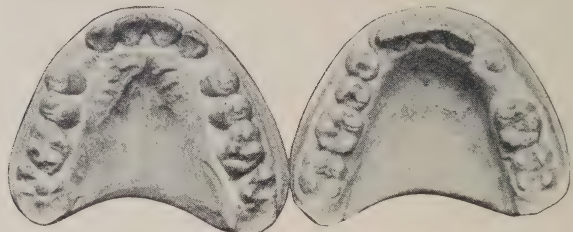

Fig. 804.[1]

Occasionally, extraction on these lines does not produce the desired results, but the failures are often to be traced to asymmetrical extraction rather than to the particular line of treatment.

Where the deciduous teeth are decaying on all surfaces—a condition not infrequently arising from the sucking of sugar bags or the constant presence of an easily fermentable carbohydrate on the surfaces of the teeth—a considerable improvement can be effected by careful regulation of the diet and regular cleansing of the teeth, combined with local treatment of the teeth. For local treatment no drug is more efficacious than nitrate of silver, which should be applied to all the carious surfaces of the teeth. A small portion should be melted on the end of a steel instrument so as to form a small bead which can be applied at any point with accuracy and safety. About four applications should be made at intervals of about a week, and afterwards at regular intervals of three months. Once a day spirits of wine should be applied to the teeth as follows: The surfaces of the teeth should be thoroughly dried, the spirit applied on cotton-wool, and the saliva kept away, if possible, for one or two minutes. The spirit, in evaporating, dehydrates the dentine and apparently hardens the surface. Twice a day, morning and evening, an alkaline mouth-wash should be used. If these directions are faithfully carried out, the teeth can often be retained for the normal period. Nitrate of silver must be applied with caution. On no account should it be held between the blades of conveying forceps, as it may slip from them and pass either into the larynx (as is known to have happened in one case), or into the

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[1] From *Royal Dental Hospital Reports.*

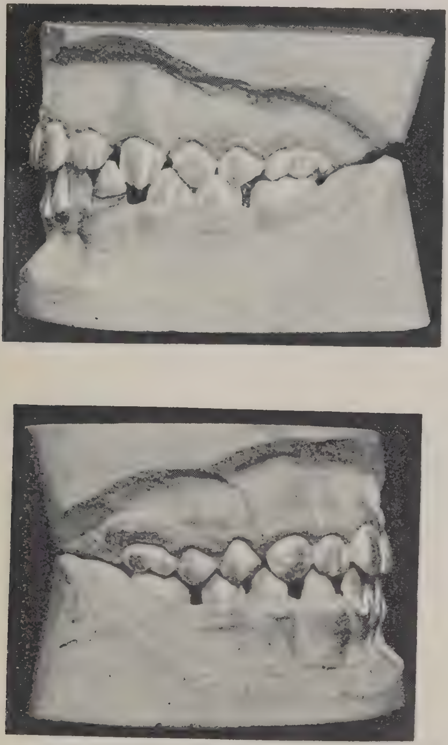

Fig. 805.[1]

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[1] From *Royal Dental Hospital Reports.*

stomach. If nitrate of silver passes into the larynx, inversion might be tried, but skilled surgical aid should immediately be sought; if it passes into the stomach, a plentiful supply of common salt should be given in order to create a chemical reaction leading to the formation of the insoluble and inert chloride of silver.

The practitioner should impress on parents the importance of keeping the first permanent molars scrupulously clean during eruption, and explain to them that these teeth form the vanguard of the second dentition and that during the period of eruption the destructive agents are most active, the loose flap of gum overlying the crown acting as a food-trap.

If the first permanent molar shows signs of caries in the fissures on the occluding surface, the fissures should at once be cut out and filled with amalgam.

The removal of the deciduous teeth by extraction is dealt with in Chapter XXVII.

CHAPTER XXIV

Odontalgia and Neuralgia

Pain arising in connection with disease of the teeth is usually designated by the term " Odontalgia."

Pain from visceral disease may be:—

(1) Local, i.e., located in the part diseased.

(2) Referred to the terminations of some nerve trunk implicated in the disease; or

(3) " Painful impressions may be conducted up the sensory fibres of the sympathetic into the central nervous system, and then referred to the peripheral distribution on the surface of the body of these nerve fibres that enter the same segment. This is true visceral reflected pain " (Head).

Pain from a tooth, therefore, may be localized to the tooth, referred to another part—for example, the temporal region—or associated with a painful area in the skin. It would seem, however, better to restrict the term " odontalgia " to pain definitely referred to a tooth or teeth and to consider all cases in which the pain is referred to other parts as " neuralgia."

ODONTALGIA

Odontalgia may be divided into:—

(*a*) *Local.*

(*b*) *Referred.*

By " local odontalgia " is meant pain in or around teeth which are themselves the cause of the trouble; by " referred odontalgia " is connoted pain in a tooth which is not itself the seat of the cause.

(A) LOCAL ODONTALGIA

Nearly all morbid conditions of the teeth may be cited as causes of local odontalgia. For convenience they will be grouped under:—

(*a*) Morbid conditions of the periodontal membrane.

(*b*) Morbid conditions of the pulp.

The principal affections under the first head are acute and chronic periodontitis and their sequelæ, and under the second, acute and chronic pulpitis.

Local odontalgia may be acute or chronic, and for practical purposes the source of the pain may be regarded as either the pulp or the periodontal membrane.

(1) Acute local odontalgia is generally due either to acute pulpitis or to acute periodontitis. *If due to pulpitis*, the pain will be of a sharp, shooting, throbbing character, more severe when the patient assumes the horizontal position, and greater at night than in the morning. Paroxysms of pain will also be caused by alternations of temperature. A small pledget of cotton-wool placed in the cavity and gently pressed upon with a blunt instrument will generally produce pain, as in this form of odontalgia the pulp is usually exposed. In a few cases the application of cold brings relief, while heat intensifies the pain. A condition of this character points to a suppurating pulpitis, the cold constricting the arteries and so reducing the blood-pressure, the heat dilating the vessels and therefore increasing the blood-pressure. A sharp, shooting pain, associated with marked tenderness of the tooth to pressure, usually implies tension in the pulp chamber from a putrescent pulp.

If periodontal inflammation is the cause, the pain will be of a dull, gnawing, constant character. Percussion of the tooth with an instrument will generally cause pain. (Where pain arises in connection with the pulp, percussion does not as a rule cause pain.) Pressure with the finger upon the crown of the tooth will also produce pain, and the alveolar process is usually tender. A pledget of cotton-wool introduced into the cavity, if one exists, will not give rise to any pain except that which is caused by the pressure transmitted to the periodontal membrane. Alternation of temperature from hot and cold fluids may affect the pain, but not to the same extent as in pulpitis. By limiting the heat or cold to the tooth, the source of pain can be easily diagnosed. With periodontitis, pain will not be felt.

The *treatment of acute local odontalgia* depends upon the cause. The remedy for each morbid condition has already been dealt with in previous chapters. Temporary relief of the pain in cases of pulp trouble may be obtained by applying to the cavity, on a piece of cotton-wool, some sedative, such as oil of cloves, oil of peppermint, or carbolic acid, and covering over the drug with some loose dressing, such as cotton-wool dipped in gum sandarac or mastic. Periodontal pain can generally be relieved by the application of tincture of iodine, to which some tincture of aconite may be added. When the pain is due to tension in the pulp cavity from a putrescent pulp, relief can be obtained by opening the pulp chamber and so giving exit to its contents.

(2) Chronic Local Odontalgia.—The *causes*, like those of the acute form, may either be connected with the pulp or with the periodontal membrane. *The symptoms arising from the pulp* will be pain at irregular intervals, but less intense than in the acute form, and a tendency for the pain to wander and follow the course of the nerve.

Alternations of temperature, or the application of irritant food substances, such as sweets, sours, &c., generally produce a paroxysm of pain which may pass away at once or continue for some time. When the odontalgia arises *from the periodontal membrane*, the patient will complain of a grumbling sensation in the tooth and tenderness on pressure. The gum over the alveolar process will be slightly swollen, congested, and tender to pressure. The pain is usually constant, not paroxysmal, like the pain arising from pulp trouble, but it may be affected by alternations of temperature. A frequent cause of local odontalgia, and one that is often overlooked, is absorption of the septa between the teeth in chronic periodontitis. Food collects in the space formed, and pain results owing to pulp irritation viâ the cemental tissue or by infection viâ the periodontal membrane.

The *treatment*, as in the acute form, depends upon the cause.

(B) REFERRED ODONTALGIA

Referred odontalgia may arise from many causes.

Any conditions which give rise to irritation of the terminal portions of the fifth nerve and its connections may cause reflex odontalgia, and by far the commonest condition which comes under this heading is that which is *dental in origin*, i.e., where the cause lies in a tooth which is not itself the seat of pain. Such cases are of frequent occurrence. A patient complains of pain, say, in a mandibular molar, which, on examination, is found to be free from disease, the cause eventually being discovered in, perhaps, a maxillary tooth. This condition, generally called "referred toothache," is at times so pronounced that manipulation of the offending tooth will cause paroxysms of pain in the sound tooth, and in one case within the author's recollection the application of arsenic to the pulp caused pain in the sound tooth during the process of devitalization. Pain may be referred from a maxillary to a mandibular tooth, or the reverse; it may also be referred from one tooth to another on the same side of the same jaw. Perhaps the most common and most instructive example of referred pain is that of a mandibular third molar causing symptoms in a mandibular premolar. Pain is never referred across the median line of the mouth. *Morbid conditions of the periosteum of the jaws, and ulcerations of the mucous membrane*, &c., may act as causes of odontalgia, and likewise *operations upon or morbid conditions of the eye and nose.* Cases supporting the latter statement are quoted by Galezowski and Macnaughton-Jones.

Toothache is frequently met with in patients with uterine troubles; in those with disorders of the alimentary tract, and in those who are the subjects of malaria, gout, rheumatism and syphilis. The probable explanation is that the blood is charged with toxic matter, and slight lesions of the teeth cause pain which would not be felt under ordinary conditions.

The diagnosis of referred odontalgia cannot always be readily arrived at. If no local cause can be found for pain which is referred by a patient to a tooth or teeth, a systematic examination of all the teeth must be carried out. As this examination is practically similar to the method to be pursued for investigating cases of neuralgia, it will be considered under that heading.

NEURALGIA

Neuralgia is a term used to denote pain in the course of the nerve, or within the area of its distribution. When pain occurs in connection with the fifth nerve, it is known as trigeminal or trifacial neuralgia. It is not itself a disease, but only a symptom of organic and functional disease. To this statement, however, an exception must probably be made in the case of "epileptiform neuralgia," which is held by some to be a definite affection of the nervous system.

Many different conditions are described under the name neuralgia, and these Head divides into:—

(A) Neuralgia quinti major (tic douloureux, epileptiform neuralgia).

(B) Neuralgia secondary to disease of the nerves of the head, for example, tumours involving the fifth nerve.

(C) Neuralgia minor.
  (*a*) Visceral referred pain due to disease of the intimate structure of some organ of the head.
  (*b*) True neuralgia minor.

(D) Neuralgia secondary to general disease, such as anæmia, hysteria, malaria, &c.

(A) Neuralgia major is considered by some authorities to be a definite disease of the nervous system with a distinct course and character. An excellent descriptive account of this disease is to be found in Head's article on trigeminal neuralgia (Allbutt's "System of Medicine," vol. vi, p. 724). The disease is of importance to the dental practitioner, as many of these cases come under his notice in their early stages. In the early stage, the disease simulates a simple neuralgia, flashes of pain starting from one or more foci. The paroxysms increase in severity and duration, until they become almost unbearable. When the disease is fully developed, the paroxysms of pain are distressing to the onlooker. On the side of the head and face affected there are "alternate flushes and pales, and the muscles are in violent spasm, the skin sweats profusely, and the mouth and eye pour out saliva and tears. At the height of an attack the pulse fails, and the patient becomes almost unconscious from pain and shock. The paroxysms are started by a stimulus of any degree or kind applied to the sensory area to which the pain is referred, or may be quite spontaneous."

The Gasserian ganglion would seem to be the starting point of these impulses, because the removal of the ganglion cures the disease. There is, at present, no known microscopical method which will enable a normal Gasserian ganglion to be distinguished from one removed from a patient affected with neuralgia major.

In an admirable paper on this disease, R. Rollinson-Whitaker[1] states that the disease, when at all severe, is never seen in patients who do not also show signs of arterio-sclerosis, and he inclines to the view that in about 90 per cent. of the cases the exciting cause lies in the mouth. In the case of patients with chronic sepsis, he thinks that "a steady stream of afferent impulses ascends, so slight that they are not noticed save when something causes an extra outburst; and these, so to speak, try the patience of a long-suffering Gasserian ganglion to such an extent that all that is needed to cause it to burst into paroxysms of pain some day is a new and severe pain stimulus—maybe of very short duration—or even the general constitutional depression which any acute intercurrent disease may so readily cause."

As regards the possibility of sepsis in the mouth acting as the cause, it would be idle to question this author's argument merely because in many of these cases the teeth are sound. In recent years our views as to what is a "sound" tooth have changed. A tooth, although quite free from caries, may be the seat of a chronic periodontitis, and it is this type of tooth which is so frequently regarded by the medical practitioner as normal. Nor is it reasonable to assume that the teeth cannot have caused the disease because their removal fails to effect a cure. It is quite feasible that, before their removal, and owing to their presence, the seeds of a disease may have been sown which may subsequently fructify as the result of pain stimulus.

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[1] "Concerning Cranial Neuralgia," *Brit. Dent. Journ.*, vol. xxx, p. 193.

Victor Horsley[1] states that he has seen cases where the neuralgia had arisen from an ascending neuritis traceable to chronic osteitis of the tooth sockets.

(B) Neuralgia due to organic disease of the fifth nerve is difficult to distinguish from the pain of neuralgia major. The pain may be intense and radiate over the area supplied by the nerve, or it may be local, although paroxysmal and active in character. In differentiating between this type of neuralgia and neuralgia major, it must be observed whether the pain is " usually accompanied by a marked loss of sensation over the area to which the affected branch is distributed."

(C) Neuralgia Minor.—(*a*) **Visceral Referred Pain.**—The reason for cutaneous tenderness in visceral disease is explained by Head as follows:—

" When impulses pass up sensory sympathetic nerves from an organ which is diseased they set up a disturbance in the segment to which they are conducted. Now any second sensory impulse from another part, e.g., from the surface of the body, which passes into this same segment, will be profoundly altered, for it no longer falls into a normal and quiescent segment of the nervous system, but into one whose activity is already disturbed. The resultant stimulus, conducted upwards towards the brain, therefore differs from that which would have passed inwards from that segment under normal circumstances. The second stimulus will appear to be exaggerated, or may perhaps undergo some actual increase in its passage through the excited segment."

" Thus any otherwise painless stimulation applied to the surface of the body falling within the area supplied by fibres that enter the disturbed segment, will appear to be painful, and the skin will be said to be tender."

" In the head, these areas are supposed to represent the segmental origin of the nerves for pain, heat, and cold."

The exact relation of each tooth to the segmental areas seems to vary. The following table is given as approximate:—

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[1] *Brit. Med. Journ.*, September 9, 1905, p. 556.

Maxilla.	
Incisors	Fronto-nasal.
Canine	Naso-labial.
Premolar I.	,,
,, II.	Temporal or maxillary.
Molar I.	Maxillary.
,, II.	Mandibular.
,, III.	,,

Mandible.	
Incisors	Mental.
Canine	,,
Premolar I.	,,
,, II.	Doubtful.
Molar I.	Hyoid.
,, II.	,,
,, III.	Superior laryngeal or hyoid.

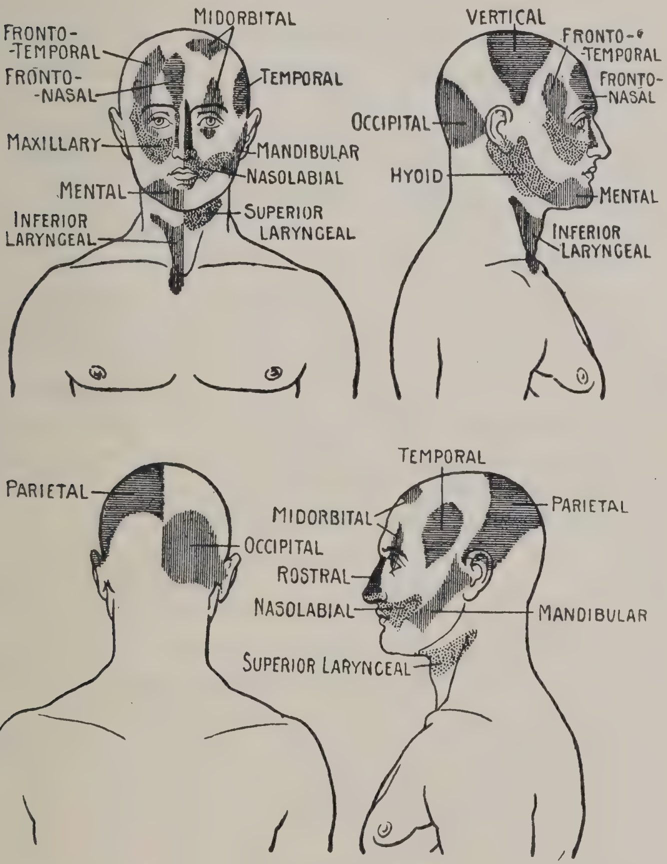

FIG. 806.[1]

The diagrams (fig. 806) show these areas, and the maxima points of these areas.

The method of testing for the superficial tenderness is by means of the blunt end of a pin. To the normal skin the touch feels blunt, but when the skin is sensitive the patient complains that the touch hurts, and that the part is tender, or he may fancy that he is being pricked. The tender area over the hairy scalp may be defined by gently pulling the hair, while with skin which overlies soft structures, such as the neck, gentle pulling between the fingers is advised.

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[1] From Allbutt's "System of Medicine."

Head's observations are interesting, but further investigations are required before their practical value in diagnosis can be definitely determined. The "segmental" areas are not to be confounded with so-called "foci" of pain observable in certain neuralgias.

It must be clearly kept in mind that the "segmental" areas do not correspond to the distribution of the peripheral branches of the cranial nerves, and the maxima points do not correspond to the so-called "foci" of pain experienced in certain neuralgias.

(*b*) **True Neuralgia Minor.**—In this form of the disease the pain is "neuralgic" in character; is of a darting, shooting type, and closely resembles neuralgia major. Usually there is no superficial tenderness; *but when tenderness is present, the sensitive area corresponds to the peripheral distribution of the affected nerve trunk.*

Causes.—Any disease to which the teeth are liable is to be regarded as a cause of **neuralgia minor.** The most frequent causes are chronic inflammation of the pulp and chronic periodontitis starting at the gingival margin. General conditions which lower the resistance of the tissues, such as fatigue, rheumatism, and anæmia, increase the intensity of the attacks of pain.

Diagnosis.—The diagnosis of the cause of facial neuralgia is important because the treatment must depend on the cause, and all cases which come under notice should be subjected to a systematic examination. The patient should be questioned as to the character of the pain, in order to discover whether the pain arises from the pulp or from the periosteum. It is also important to ascertain if the pain is periodic, while at the same time the knowledge of its situation is useful in assisting to localize the position of the tooth should the neuralgia be of dental origin. Thus, pain in the infra-orbital or supra-orbital region points to maxillary teeth; pain in the ear, shooting down the shoulder, points to mandibular teeth; while pain over the parietal eminence indicates trouble from either maxillary or mandibular teeth. Next, the teeth must be examined for carious cavities, and, should any be found, a search should be instituted to discover if any chronically inflamed pulps exist. This examination should be carried out with a mirror and a probe, care being taken to look for approximal cavities near the gum margin.

After this, periodontal causes should be excluded by pressing and tapping the teeth and carefully examining the "pockets" around the teeth. Irritability of the pulp through pathological changes must next be eliminated by looking for exposed surfaces of dentine or cement. Exposure of the root in chronic local periodontitis is a fruitful cause of neuralgia (see p. 494). Each tooth should next be tested with heat and cold, and, in doing this, attention should be bestowed upon teeth containing large metal fillings. In testing with heat, a ball of base-plate gutta-percha should be made hot and applied to each tooth separately; while the test with cold is easily carried out by touching each tooth with a small pledget of cotton-wool dipped in ice-cold water, or spraying with ethyl chloride. If a jet of cold water is used from a syringe, the water will run over two or three teeth at a time, and so prevent ready detection of the offending tooth. It must not be overlooked that most teeth with live pulps, if submitted to the above treatment, will respond to the changes; but when the pulps are healthy, the condition will be quite transient, while, if diseased, the test will probably set up an acute paroxysm of pain. In cases of doubt the neighbouring teeth should be tested as well as the suspected tooth. The pain started in the affected tooth will be greater in comparison with that in the approximal teeth. Suppurative conditions of the periodontal membrane are to be regarded as frequent causes of trigeminal pain. The exposure of the roots leads to irritability of the pulps from thermal and other irritations, while in advanced conditions the pulps may be affected viâ the apical foramen by spread of inflammation from the periodontal membrane.

If a cause has not been discovered by the above-mentioned examination, the absence of third molar teeth, a frequent cause of neuralgia in those between 18 and 30, should be considered. Such causes as morbid conditions of the periosteum of the bony canals through which the nerve passes, the peripheral irritation in other parts of the distribution of the fifth nerve, must next be excluded. Finally, the presence of disease of the maxillary sinus or tumours in the region of the trunk of the nerve should be looked for, and the question of organic disease in the brain and neuralgia major should be considered.

Treatment.—If the neuralgia is dental in origin, the cause must be removed by the measures indicated for the treatment of such lesions. When the cause is constitutional, remedies appropriate to the condition must be adopted. For instance, if arising in connection with general debility, anæmia, or overwork, a general tonic treatment with such drugs as iron, quinine, and arsenic will be beneficial, careful attention being paid to the condition of the bowels. Aspirin (10 to 15 gr.) is useful in neuralgias of peripheral origin. If of malarial origin, quinine in large doses, i.e., 5 to 10 gr., will bring immediate relief, and, if given before an attack, will, in some cases, ward it off, and, in others, greatly minimize its severity. Should there be any suspicion of syphilis, iodide of potassium would be indicated; while with gout and rheumatism the same drug may prove useful. In addition to the internal administration of drugs, local applications may be tried, such as chloral and camphor in equal parts, aconite and chloroform, or counter-irritants, such as cantharides, capsicum, and mustard. If no cause can be found, and the above treatments fail, the drugs which may be termed "neuralgic specifics" should be tried, amongst these being tinct. gelsemii, veratrina, butyl chloral hydras. In combination with these, such drugs as dilute hydrobromic acid, chloral and bromide of potassium may be given. In more severe cases, the injection of morphia may be resorted to.

In cases where treatment by drugs fails and the patient continues in great pain, injections of alcohol may be tried, and failing relief from these, surgical methods may be adopted. These questions belong to the domain of general rather than dental surgery.

The following articles will repay perusal:—

Head, H. "Trigeminal Neuralgia," Allbutt's "System of Medicine," vol. vi, p. 724.

Rollinson-Whitaker, Ray H. "Concerning Cranial Neuralgia," *Brit. Dent. Journ.*, vol. xxx, p. 193.

"Discussion on Neuralgia," Dental Section, British Medical Association, September 9, 1905, p. 546.

CHAPTER XXV

Diseases arising from Sepsis in connection with the Teeth

General Considerations—Pathological Conditions attributable to Dental Sepsis—The Mouth and Associated Parts—Gastro-intestinal Affections—General Malnutrition—Glandular Secretions—Chronic Rheumatism—Chronic Arthritis—Anæmia—The Skin—The Nervous System—The Cardio-vascular System—The Eye—The Ear—General Infection—Intermittent Fever—Cancer—General Conclusions

In the preceding chapters the various pathological processes arising in connection with the teeth have been considered, and it has been shown that septic and infective conditions are associated with many of these processes. These processes or conditions are now commonly grouped under the term "dental sepsis." It is necessary, therefore, for the student to bear in mind that the term "sepsis" is used in a broad sense, and includes infective as well as septic processes commencing not only in the gingival tissues, but also in the tissues around the apices of the teeth.

In recent years there has been an increasing tendency to recognize the mouth as a focus of infection. It is, therefore, the primary duty of the dental practitioner to assure himself that the mouth is kept as aseptic as possible, and he should hesitate to undertake any operation which is likely to produce sepsis.

(A) GENERAL CONSIDERATIONS

(1) The Normal Conditions of the Alimentary Canal

In the normal mouth the teeth are arranged in a regular arch; the gums are firm and of a light pink colour and are attached to the teeth at their necks. In the process of mastication particles of food tend to cling about the teeth, especially around the necks of the teeth where the gingival margin is attached in such a way as to leave a slight trough, but, when normal conditions prevail, the mouth is quickly freed of food debris by the combined action of the cheeks, tongue and saliva.

In the healthy mouth certain organisms are always present. The majority of these organisms cannot be grown in ordinary culture media, and, of those which can be grown, the streptococci are in "overwhelming preponderance." When food is being taken, and probably at other times, adventitious organisms are introduced into the oral cavity.

Various factors contribute towards the maintenance of the "bacteriological balance" in the mouth, e.g. (*a*) the mouth is constantly flushed with saliva which carries the organisms to the stomach; (β) phagocytes are incessantly passing up between the epithelial cells and either take up the organisms or discharge their bactericidal content; some, "having performed their functions, undergo dissolution or are swept away by the currents of saliva," while others find their way back into the subjacent tissues and are rapidly destroyed; (γ) the bacterial struggle for existence is probably a contributory factor.

The organisms reaching the stomach from the mouth are mostly killed or inhibited by the action of the gastric juice, and a few hours after meals the duodenum may be found quite sterile. In the small intestine bacterial growth starts afresh, the rate of growth increasing as the colon is approached; at the colon bacterial multiplication reaches its maximum. The bile exercises a selective action on the organisms, and, while checking the growth of certain organisms such as the delicate streptococci, the pneumococci and the *Bacillus proteus*, it has no effect on the typical intestinal bacteria such as the *B. coli* group and the hardier streptococci. The bacteria in the intestines are disposed of in two ways. Some are expelled with the fæces, and these are probably in the majority; while others find a passage through the intestinal wall. The latter are either arrested in the subcutaneous lymph nodules, or, evading these, are either trapped in the mesenteric and retro-peritoneal lymph glands, or reach the venous radicles of the portal vein where the endothelial cells arrest the leucocytes with the contained bacteria.

With regard to the toxic products of the bacteria, it is, says Andrewes,[1] "conjectured that such injurious substances absorbed from the alimentary canal as may escape the alchemy of the liver are neutralized by the secretion of certain of the ductless glands—for example, the thyroid."

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[1] "Discussion on Alimentary Toxæmia," *Proc. Roy. Soc. Med.*, vol. vi, No. 5 (Supplement).

Briefly, it may be said that under normal conditions the organisms in the alimentary canal are efficiently dealt with by the body defences and their presence causes no ill-effects.

(2) Abnormal Conditions of the Alimentary Canal

Any septic condition of the mouth adds fresh organisms, the normal flora being increased and new varieties appearing. "The abnormal products of tissue reaction to injury are present, that is, inflammatory exudation which is rich in proteid, and an enormous increase of dead cells, epithelial and otherwise." The abnormal flora in conjunction with abnormal environment modify the virulence of the organisms in the direction either of attenuation or of exaltation.

The local effect of this increase of organisms is to undermine and weaken the epithelial covering, which then affords a passage for the organisms into the deeper tissues, and, in diseases of the periodontal membrane, the organisms constantly pass into the medulla of the bone and are absorbed into the general circulation. This latter condition is manifestly present where there is marked rarefying osteitis, and is probably also present in many cases where there is little bone destruction.

The presence of an increased number of organisms and their toxins in the stomach generally results in a gastritis, which in its turn lessens the efficiency of the gastric defences, and an overwhelming number of organisms pass into the small intestines. Under these conditions the defences of the intestines are taxed to their uttermost and a greater number of organisms pass from the intestinal surface into the system. In the opinion of Adami, this condition often leads to a sub-infection rather than an active infection. "The bacteria carried in do not multiply and set up foci of suppuration; they are destroyed, but with their destruction the liberation of their toxins causes a poisoning of the cells immediately around them, and the accumulative actions of these toxins, whether locally or at a distance, upon the liver cells, for example, brings about the death of certain cells and replacement by fibrous tissue."

The toxic products of the bacteria are also increased, and, as the normal defences are unable to neutralize them, they pass these defences and are distributed to the tissues, attacking those cells for which they have the requisite chemical affinity. In this manner the organisms or their toxins are absorbed into the blood-stream either directly through the bone, or indirectly viâ the intestinal canal, and the pernicious influence of dental sepsis thus passes deep into the system and starts other diseases.

Caution is necessary in assuming that dental sepsis is the cause of some other disease with which it is associated until all other possible sources of infection have been eliminated. But even where sepsis in the mouth is not the primary cause, it must not be neglected; otherwise, by lowering resistance, it will assist the pathological process.

It may reasonably be asked why dental sepsis, which is so prevalent, does not more often lead to remote conditions. The answer is to be found in the general defences of the body against infection. As long as the reaction of the tissues is able to neutralize the toxic products or destroy the bacteria a normal standard of health may apparently be maintained. But it would appear that the reaction of the tissues to infection cannot be maintained indefinitely and that constant attack weakens the defences until they eventually break down and the tissues become infected. This explanation would fully account for cases in which a septic condition of the mouth has existed for years without giving rise to any remote condition, and has then been followed by a rapid decline in health and the appearance of a definite lesion.

(B) PATHOLOGICAL CONDITIONS ATTRIBUTABLE TO SEPTIC PROCESSES IN THE MOUTH

(1) The Mouth and Associated Parts

Pathological changes may arise in the mucous membrane of the mouth and pharynx through the spread of infection along the mucous surface, and ear trouble may be started by extension of the infection down the Eustachian tube. When **pharyngitis** arises from dental sepsis the teeth generally concerned are the mandibular molars, especially the third; the deep pocket which is so often present behind the third molar is a favourable breeding ground for organisms, and a definite track of inflamed tissue passing from these teeth across the pillars of the fauces can frequently be traced.

The infection may spread to the larynx and set up a chronic **laryngitis** or to the œsophagus and give rise to symptoms of **dysphagia.**

P. Daniel[1] was the first to draw attention to the possibility of certain cases of dysphagia being due to dental sepsis. In the case of five patients referred to him as suffering from dysphagia due to œsophageal cancer, repeated examination and the passage of instruments revealed no stricture. All the patients had marked dental sepsis, and upon the removal of the sepsis the symptoms entirely disappeared. The explanation is no doubt to be found in the fact that sphincters when irritated tend to contract, as, for example, in cases of pyloric spasm. In the œsophagus, about the level of the cricoid cartilage, there is a sphincter, which was first described by Everard Home and more recently by A. Keith; and it is probable that in the cases mentioned by Daniel contraction of this sphincter was brought about by the dental sepsis.

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[1] *Brit. Med. Journ.*, January 5, 1910, p. 121.

The persistent damage to the oral epithelium caused by sepsis would seem in a few instances to be closely connected with the appearance of carcinomata. In cases of **squamous-celled carcinoma** starting in the buccal surfaces of the cheeks there is invariably a history of long-continued sepsis in connection with the adjacent teeth, and, although many of these patients are syphilitic, the frequent association of dental sepsis with the carcinomatous condition strongly suggests that the two conditions are related.

Dental sepsis is an important factor in the production of **chronic superficial glossitis.** Syphilis, alcohol, and excessive smoking are generally regarded as the principal causes of this condition, but from observation of numerous cases it would seem that an advance to the stage usually known as leucoplakia does not occur without dental sepsis.

As already explained (p. 525), deep infection of the bone is frequently present in cases of periodontal disease. It is conceivable, therefore, that this deep infection may start changes in the soft tissues of the bone. There is evidence that many of the **slow progressive enlargements of the jaws,** more especially of the maxilla, seen in adults, are due to infection from the periodontal membrane. A case typical of this condition was recorded by H. Watson Turner.[1] The enlargement started in the maxillary right molar region, and in twelve years gradually involved the whole alveolar bone of both maxillæ. When seen there was marked periodontal disease. Radiographic examination showed that both sinuses were completely obliterated, but that the nasal passages and orbits were clear. Histological examination showed the condition known as "osteitis fibrosa." No bacteria could be demonstrated. I have also seen three cases of **myeloma** in which there was strong evidence that dental sepsis was the determining cause.

The constant absorption of toxins viâ the lymphatics may lead to **lymphadenitis.** The glands affected by the teeth and gums are:—

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[1] *Proc. Roy. Soc. Med.,* vol. xiii (Odonto. Sec.), p. 64.

(*a*) *Submaxillary group*, situated in the digastric triangle and running along the margin of the mandible in close relation with the salivary gland. Into this group drain the lower gums, lips, floor of the mouth, sublingual and submaxillary salivary glands, and lymphatics from the tissues around the roots of the teeth. These glands send their lymph partly into the superficial and partly into the deep cervical glands.

(*b*) *Suprahyoid or submental group*, three or four in number and situated between and superficial to the anterior bellies of the digastrics. Into these drain the central portions of the lower gums and lips and the tip of the tongue.

(*c*) *Parotid group*, some of which are situated superficially and others more deeply in the parotid gland. Into these may drain the lymphatics from the region of the maxillary molars.

(*d*) *Superficial cervical* along the external jugular veins, receiving lymphatics directly from the gums and indirectly viâ the submaxillary glands, but principally from the scalp and skin of the neck.

(*e*) *Deep cervical* over the internal jugular vein. These receive lymph from the gums directly or viâ the submaxillary glands.

Chronic lymphadenitis is important because the lymph glands frequently become the seat of tubercle. There is considerable difference of opinion as to the exact relation between septic teeth and chronic lymphadenitis. It is possible that the divergence of views is to be attributed to the personal equation, that is, to the manner in which the facts are observed and noted; thus, a gland which one observer would describe as enlarged would by another be regarded as not abnormal. It is questionable whether a gland should be described as enlarged simply because it is palpable. The most satisfactory test would seem to be to put the skin on the stretch, and if the gland can then be seen, to consider it as enlarged. The test may be carried out as follows: If the glands on the right side are involved, turn and stretch the head towards the left and look at the neck with the light athwart. If the glands cause irregularity of the surface they should be considered as enlarged.

Because septic teeth are associated with chronic lymphadenitis, it does not follow that the glandular enlargement is directly attributable to the teeth; infection from the tonsils, and adenoid tissue around, is probably a much more frequent cause of lymphadenitis than septic teeth.

When the enlarged glands become the seat of tubercle, the infection probably reaches the glands viâ the blood-stream and not directly viâ the lymphatics. The glands damaged by the absorption of toxins are in a state of diminished resistance, and are, therefore, liable to become infected by the tubercle bacillus. There is a growing impression among pathologists that the tubercle bacillus gains an entrance to the body by way of the alimentary canal, but in whatever way the tuberculous organisms reach the glands, it is an important and indisputable fact that dental sepsis and tuberculous glands are frequently associated.

(2) Gastro-intestinal Affections

There is ample evidence to show that dental sepsis and gastric affections are often closely related. In many instances the gastric condition is the direct result of the constant presence of septic and infective saliva, and cases are constantly occurring in practice in which, with the removal of the dental sepsis, the gastric condition completely clears up. In such cases the chain of events is probably as follows: The food, imperfectly masticated and incorporated with infected saliva, undergoes excessive fermentation, with the result that, sooner or later, a catarrhal inflammation of the gastric mucosa is started. The **chronic gastritis** is probably of the mucous variety in which the acidity is always slight—a point of considerable importance as far as the inhibition of the microbes is concerned. The catarrhal inflammation is kept alive by the constant presence of the septic matter and may become infective in character.

An examination of the contents of a starved stomach will often show the presence of living micro-organisms. With continued exposure of the gastric mucous surface to infection from the mouth the catarrhal inflammation may lead to glandular atrophy and an increase of the interstitial connective tissue.

Chronic gastric ulcer is frequently associated with dental sepsis, and there is an increasing belief that the two conditions are causally related. Further, it is held that chronic gastric ulcer predisposes to the development of **gastric carcinoma.** F. St. J. Steadman examined the dental condition of 21 cases of gastric cancer and found periodontal disease in every one; in 14 cases it was severe, in 5 it was moderate, and in two it was slight. The evidence obtained points strongly to an intimate relationship between dental sepsis and carcinoma of the stomach. Clinical evidence does not suggest that the gastric ulcer seen in young girls is due to dental sepsis, for in many cases the mouth is quite healthy. If, however, dental sepsis is present, the healing of the ulcer will be retarded.

As the gastric juice, under normal conditions, inhibits or destroys the majority of organisms entering the stomach, the number passing into the duodenum is relatively small. Gastritis interferes with this bactericidal power of the gastric juice, with the result that there is an increase in the number of organisms passing through the pyloric opening and consequently a greater risk of infection in the small intestine.[1]

There is reason to think that a **duodenitis** may result from the increased number of organisms passing through the pylorus, and that the infection may spread along the common bile-duct and cystic duct to the gall-bladder. A chronic cystitis is started, a condition which, pathologists maintain, is necessary for the formation of gall-stones. It seems probable that infection may spread along the pancreatic duct and give rise to a **pancreatitis,** which will cause pressure on the common duct and thus lead to jaundice. This view is supported by the fact that, in many cases of jaundice, Cammidge's pancreatic reaction[2] may be obtained.

With a general gastro-enteritis established, toxic matter will be produced in abundance, which, on being absorbed, will initiate, or influence the course of, other lesions.

To sum up briefly, it would seem that dental sepsis may lead to gastritis and that gastritis leads indirectly or directly to a general infection of the intestinal canal, but it is not therefore to be assumed that all infective or septic conditions of the small and large intestines are due to dental sepsis. Granting, however, that the primary cause of the intestinal condition is connected with the intestine itself, it is clear that dental sepsis must have a profound influence on the course of that condition, and that the first step in treatment should be to remove all sources of sepsis from the mouth.

Cases of **sprue** (psilosis) often improve with the removal of the dental sepsis. Sprue is a chronic disease of the digestive tract; it is unattended by fever and has as its most marked symptoms diarrhœa, rawness and soreness of the tongue and throat, with a liability to the formation of superficial ulceration of the buccal mucous membrane.

In one case the patient had undergone prolonged treatment, including a course of vaccines; but no improvement occurred until the removal of all the teeth, and since then there has been no return of the symptoms of sprue.

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[1] Hankin, as quoted by Adami, found that, in normal health, he could swallow billions of living virulent cholera spirilla without ill-effect. Repeating the experiment when he was suffering from transient gastric catarrh he developed acute diarrhœa with spirilla in the fæces.

[2] In certain pancreatic lesions the kidneys secrete a substance which, in hydrolysis, gives the reaction of a pentose.

(3) General Malnutrition

Of the general pathological conditions attributable to dental sepsis, by far the commonest is that which is clinically designated by the term "general debility." There is a feeling of ill-health, a lack of energy, tiredness at the end of the day's work, a sallow, unhealthy appearance of the skin and frequently a history of gastro-intestinal disturbance. The symptoms are indefinite. This condition must be regarded as the result of the continued absorption of small doses of toxins, and should be classed as a chronic toxæmia. In a milder form the patient complains of "being below par," and many persons become so accustomed to this indifferent state of health as to regard it as normal, but with removal of the septic focus and an improvement in their general condition they realize that their previous condition was abnormal. In the most severe cases the toxæmia is due to direct absorption into the blood-stream of the toxic product around the teeth. In other cases the toxæmia is due to absorption of toxins from the intestine, the abnormal condition of the intestine being traceable to dental sepsis. Rapid and marked improvement in many cases of general debility follows treatment of the teeth, the improvement, be it noted, commencing before the insertion of dentures.

If dental sepsis can so profoundly affect the general metabolism, it is self-evident that it must have a baneful influence on other pathological processes started by other causes. As an example we may take the condition known as **chronic pulmonary tuberculosis.** Here an infecting agent is being resisted by the defences of the lung tissues; if the defences are strong the disease is kept in check—if weak, then the disease becomes active and spreads. Any condition, therefore, which lowers the general tissue resistance must exert an influence on the lung condition. A paper by R. C. Wingfield dealing with this subject was published in the *Lancet* (July 18, 1914). He records the results of radical dental treatment in forty-one cases treated in the tuberculosis department of St. Thomas's Hospital. In twenty cases of undoubted pulmonary tuberculosis, one half showed distinct improvement and the other half no improvement; in twenty-one cases of doubtful pulmonary tuberculosis, fifteen showed distinct improvement. Of the cases of undoubted pulmonary tuberculosis not showing improvement, one patient died, three cases were recorded as worse, and the remainder as unaltered. In the case of the patient who died and in two cases out of the three recorded as worse, the pulmonary tuberculosis was active. These facts are most instructive. Where the disease is in an active form the bodily defences are unable to hold the infecting agent in check. The effect of the removal of the teeth is to increase for a period the amount of toxins absorbed into the circulation, and this has the effect of decreasing the local resistance of the lung tissues, with the result that the tubercular disease becomes worse. It would appear, therefore, that, in cases where the disease is active, there is good ground for delaying the radical treatment of the dental sepsis until a quiescent stage is reached, when it should be carried out very gradually.

(4) Glandular Secretions

(*a*) **Deficient Lactation.**—There is evidence that dental sepsis is sometimes responsible for deficient lactation. H. Waller[1] has drawn attention to this condition, and has found that the removal of the sepsis is often followed by a rapid improvement in the condition of a child. By way of illustration two cases may be quoted.

(i) A child was born above the average weight and was healthy in appearance. The mother had previously nursed a child with success, but this one cried unduly and vomited the milk from time to time. The child's gain in weight became unsatisfactory. Reference to the chart, fig. 807, shows that at the end of the twelfth week the child had lost the initial advantage which he had over the average child at birth. The sepsis in the mouth was treated by the removal of three suppurating teeth when the child was eleven weeks of age and two a fortnight later. The rapid improvement of the infant following the removal of the sepsis is shown in the chart.

(ii) A child was born below the normal weight and when seen at three and a half weeks of age was undersized and appeared to be wasting. The mother had a copious supply of milk. The vomiting of the child after the feeds was not due to excessive feeding as a similar condition followed feeds of a few minutes. A rapid improvement in the infant's condition followed the removal of the dental sepsis, as shown in the chart, fig. 808.

Waller's paper was based on observations on nearly 200 cases in which dental sepsis was present. In 80 per cent. of the cases improvement was observed after treatment of the dental condition.

(*b*) **Internal Secretions.**—If the secretion of the mammary gland can be so affected by mouth toxins, it is possible that the toxins may affect other secretions of the body, including those of the ductless glands. Our knowledge of the relation of the ductless glands to other conditions is yet in its infancy, but we are aware that they are intimately connected with certain abnormal conditions. It is possible that variations in the secretions of the ductless glands may be due to toxic action combined with an inherited cause.

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[1] "Dental Disease in Nursing Women," *Lancet*, November 4, 1916.

In exophthalmic goitre there is an excess in the secretion from the thyroid; marked improvement of this condition occasionally follows the removal of the dental sepsis, as is shown by the following case: A female, just before her marriage, developed symptoms of exophthalmic goitre; the condition progressed rapidly and was quite unaffected by the usual treatment. There was marked generalized periodontal disease; this was treated in a radical manner and from that time the patient made an uninterrupted recovery, and at the present time (twenty years after the com-

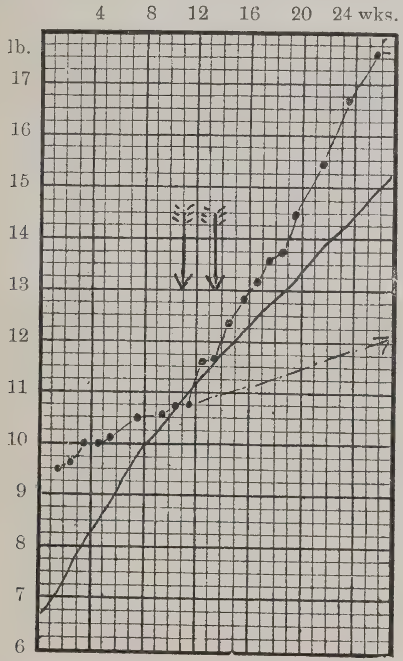

Fig. 807.—*Lancet*, p. 786, November 4, 1916.

Case 1.—Weight curve of child. The continuous line is Budin's curve. The interrupted line gives the record of the child's weight. The arrows denote the extraction of maternal teeth; three in the first case, two in the second. The direction of the interrupted line before the extraction would lead to a weight of 14 lb. at one year, after the extraction to one of 22 lb.

mencement of the disease) shows scarcely any degree of exophthalmos.

In carbohydrate metabolism a most important part is played by the internal secretion of the pancreas. This secretion conveyed by the pancreatic vein into the portal circulation enables the liver and the muscles to deal with the carbohydrates. Toxins circulating in the blood-stream may affect the pancreatic tissues and so alter the character of the internal secretion. In **diabetes mellitus** there is marked glycosuria, and W. H. Willcox informs me that in these cases he has seen marked improvement in the carbohydrate assimilation following on the removal of dental sepsis. Exactly how this improvement is brought about is not clear, but it is quite possible that the eradication of the sepsis takes a strain off the pancreas and allows the formation of the internal secretion to proceed in a normal manner.[1]

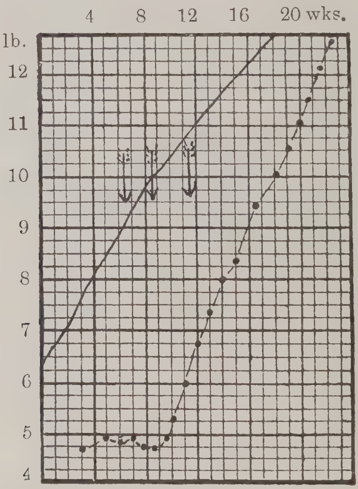

Fig. 808.—*Lancet,* p. 787, November 4, 1916.

Case 2.—Weight curve of child. Lines as before. The arrows indicate the extraction of eight teeth, twelve teeth and four roots, and eight teeth respectively.

(5) Chronic Rheumatism

It is generally conceded that many of those ill-defined conditions embraced by the terms "chronic rheumatism" and "muscular rheumatism" owe their origin to sepsis, and that the focus of infection is often in the mouth. It is a common experience to find that such conditions clear up with the removal of the dental sepsis. For example, a patient, a woman aged 40, had suffered from tarso-metatarsal rheumatism to such a degree that walking became unbearable; with the removal of a well-marked general suppurative periodontitis the foot condition completely disappeared.

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[1] L. F. Barker, *Journ. Nat. Dent. Assoc.,* March, 1920, p. 53, remarks he has seen improvement in carbohydrate tolerance in diabetics on removal of sepsis.

Wynn[1] is of the opinion that these conditions are in no sense related to acute rheumatism, but are due to a fibrositis, that is, an inflammation of fibrous tissue of various parts, for example, the sheaths of nerves, the ligaments of joints, the fasciæ of muscles. He considers that the fibrositis is always due to the presence of toxins. The determining cause is strain from unusual exertion, the constant presence of the toxins acting as a continuing cause.

(6) Chronic Arthritis

Opinions differ widely as to the classification and terminology of the various joint affections grouped together under the term "Arthritis deformans." Some authors place the various affections in different classes, while others regard them as of the same class. Clinically, two varieties are usually recognized, namely, rheumatoid arthritis and osteo-arthritis. In **rheumatoid arthritis,** or, as it is sometimes termed, "poly-arthritis," the joints of the hands and feet are generally affected. The onset may be associated with febrile disturbances; the local condition subsides, to be followed by further attacks, the joints in time being permanently deformed. In other cases commencing towards the regressive period of life, the onset is often more insidious, there are no febrile symptoms, and the condition is progressive.

In this variety of arthritis, according to Llewellyn Jones—

(*a*) The morbid process begins in the synovial and peri-articular tissues which undergo thickening and proliferation, but the cartilage, at any rate in the earlier stages, remains intact.

(*b*) The changes that ensue in the cartilaginous and bony structures are secondary and are predominantly atrophic in character.

(*c*) In some cases proliferative changes take place in the bone and cartilage, but these occasional outgrowths are inconsiderable in size.

(*d*) In the terminal stages of the disease secondary atrophic changes ensue. Thus the cutaneous and capsular tissues undergo progressive shrinkage, the joint cavity becoming obliterated with fibrous or bony anchylosis. This atrophic process involves also the shafts of the bone, the cortex becoming attenuated and the cancellous tissues replaced by scanty thin trabeculæ.

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[1] "The Relation of Oral Sepsis to General Medicine," *Brit. Dent. Journ.*, August, 1912.

In **osteo-arthritis** the disease starts in the cartilages; these become thinned, and where pressure is greatest the cartilages become worn away, the denuded ends of the bone becoming sclerosed and their surfaces eburnated. In the peripheral portion of the cartilage not subjected to pressure, proliferation takes place and osteophytic outgrowths are developed. The changes which take place in the synovial membrane are secondary in character. Clinically, the disease is not intimately connected with infective conditions. There is frequently a clear history of trauma. The big joints are generally affected and usually only one. The disease attacks both sexes equally; belongs to the middle and later periods of life and is usually associated with arteriosclerosis and senility.

There is evidence that rheumatoid arthritis is caused by an infecting agent, the pathological changes being due, in some instances, to direct infection, in others to the action of the toxins absorbed from the seat of infection. Horder[1] considers that the infective element is usually a type of streptococcus, not *S. pyogenes* but *S. salivarius* or *S. fæcialis*, i.e., streptococci of relatively low virulence, not tending to suppuration and traceable —as the nomenclature is intended to suggest—to foci in the mouth or intestine. N. Mutch[2] considers that, in a few cases, the infecting agents are staphylococci. The cases which are most likely to be traceable to dental infections are those where there is active destruction of the alveolar bone in connection with either periodontal disease or infection localized to the apices of the teeth. The rapid improvement and eventual cure which, in some cases, follow the removal of the dental sepsis is at times most striking. For example, a married woman, aged thirty, hobbled into my outpatient department in 1911, having an arthritis involving several of the joints. The teeth remaining $\begin{array}{r|l} 3\,2\,1 & 1\,2\,3 \\ \hline 4\,3\,2\,1 & 1\,2\,3\,4 \end{array}$ were loose. Radiograms showed extensive destruction of the bone and absorption of the roots of the teeth. As far as could be ascertained there was no other source of sepsis. The teeth were extracted and recovery followed. This patient has recently informed me that she has remained in good health and has had no recurrence of the arthritis. In this case it is evident that the infection arose from the teeth.

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[1] "Vaccine-therapy in Rheumatoid Arthritis," *Lancet*, April 20, 1912, p. 1053.

[2] *American Medicine* (New Series), vol. x, No. 6, p. 373.

When, in addition to the teeth, other sources of infection are present it is extremely difficult to form a definite opinion as to the influence of the dental sepsis on the arthritic condition. The following is a case in point: A man, aged about forty-two years, came under treatment for arthritis in the joints of the hands and feet. He had periodontal disease, but there was a fair degree of reparative power in the alveolar process; he was a mouth-breather —there was old tonsillar trouble in addition to symptoms of gastro-intestinal disturbance. Here, periodontal disease was in a large measure attributable to mouth-breathing: the mouth-breathing was due to the tonsillar condition, the dental sepsis aggravated the tonsillar trouble, and this increased the mouth-breathing and the periodontal disease and a vicious circle was formed. The combined dental and tonsillar sepsis aggravated the gastro-intestinal condition, and this, in turn, affected the general metabolism, including that of the teeth and tonsils, and another vicious circle was formed. Under such conditions it is impossible, with our present knowledge, to decide whether the dental sepsis was or was not the initial lesion. Nevertheless, radical treatment of the dental sepsis was necessary before the tonsillar or gastro-intestinal conditions could be dealt with. The teeth were removed a few at a time, and after each operation there was a fair degree of reaction in the joints, but there was little improvement. Removal of the tonsils failed to affect the condition materially, and it was not until after a regular course of treatment for the gastro-intestinal condition had been carried out that the patient made any headway. The arthritis has now been checked and there is considerable improvement in the power to use the limbs. In this case the dental sepsis could only be regarded as a contributory cause by aggravating the gastro-intestinal sepsis.

With regard to the variety known as osteo-arthritis, there is but slight clinical evidence that the mouth is the etiological factor. If dental disease is present, it is of a chronic type and radiograms of the alveolar process often show definite sclerosis of the lamina dura, pointing to ample reaction to any toxins affecting the periodontal membrane. In such cases the dental sepsis may be an active factor in the production of gastro-intestinal sepsis, which latter is considered by P. Daniel[1] to be an important factor in the causation of osteo-arthritis.

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[1] "Arthritis: A Study of the Inflammatory Diseases of Joints," p. 136.

The removal of teeth in cases of arthritis has led to a good deal of dissatisfaction, but this is in a great measure attributable to the fact that too much importance has been attached to the dental sepsis in cases of arthritis and the teeth have been removed without due consideration of other foci of infection. Moreover, in many cases of dental sepsis the jaws are deeply infected and, after the removal of the teeth, an infection is often still latent. At present we know of no satisfactory method of dealing with the infection which remains when the teeth have been removed. In many cases the reparative power of the tissues is on the decline. It must also be borne in mind that when the infecting agent has reached the joint, the joint itself becomes a source of infection. This is, however, no argument for the retention of the septic teeth, for it is clear that if the focus is allowed to remain the strain thrown on the joints will be greater and permanent crippling will be more likely to occur.

In a communication to the *Lancet*,[1] H. Warren Crowe expresses the opinion that dental foci are seldom the cause of infection in cases of fibrositis, arthritis and neuritis. In order to fix the cause he relies on the specific effect of a small dose of vaccine and proceeds as follows: From the apex of an infected tooth the varieties of streptococci are cultivated and a vaccine prepared. If a small dose has no effect whatever, and on the other hand a dose from 0·1 to 0·5 of a million fæcal streptococci not once but several times is followed by a flare-up together with a drop in weight of a pound or two lasting several days, then he considers the inference is that the teeth are not to blame. Taking the specific effect of a minute dose of vaccine as a criterion of pathogenicity he analysed 163 cases of arthritis, fibrositis and neuritis. He could only find 7 cases of arthritis out of 153, and 3 of sciatica and brachial neuralgia out of 10, in which the teeth were the cause and the sole cause. In two other cases removal of the teeth was followed by a flare-up of the joints. In 46 cases he considered that the teeth were probably contributory.

(7) Anæmia

In a series of papers communicated during recent years to the various journals, W. Hunter[2] has drawn attention to the association of dental sepsis with severe anæmias.

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[1] April 22, 1922, p. 814.

[2] *Lancet,* January 27, February 3 and 10, 1900. "A Discussion on Pernicious Anæmia and Allied Conditions," *Brit. Med. Journ.*, November 9, 1907, p. 1299. "Oral Sepsis as a cause of Disease in Relation to General Medicine," *Brit. Med. Journ.*, November 19, 1904, p. 1358.

Chlorosis.—This form of anæmia, so common in young females, has as its chief feature a diminution in the hæmoglobin, the colour index averaging 0·5 and being sometimes reduced to 0·1. There is no evidence to show that chlorosis is caused by dental sepsis, the condition of the mouth in many cases of chlorosis being above suspicion. At times chlorosis and dental sepsis are both present, and in such cases a cure of the anæmia is often impossible until the dental sepsis has been removed.

Septic Anæmia.—Under this name Hunter describes a condition in which the "septic factor" is predominant, and owes its origin to sepsis in connection with the oral, gastric and intestinal tract. This anæmia in its severe forms is characterized by (*a*) an oligocythæmia comparable to that found in Addison's anæmia, including the existence of poikilocytes, normoblasts and at times megaloblasts; (*b*) hæmorrhages; (*c*) dirty yellow and anæmic complexion; (*d*) the frequent existence of oral, gastric and intestinal sepsis and symptoms; (*e*) fever; (*f*) the severe and often fatal course the disease takes; (*g*) nervous effects and symptoms in many cases; (*h*) favourable prognosis, if the cause is removed in time; (*i*) chronic nephritis; (*j*) *absence of the hæmolytic and bone-marrow changes found in progressive pernicious anæmia.* There is reason to believe that this form of anæmia is at times associated with dental sepsis, as a rapid improvement often follows the removal of the sepsis.

Idiopathic or Progressive Pernicious Anæmia.—Hunter regards this type of anæmia as a "specific, hæmolytic, infectious disease, localized to the alimentary tract, with characteristic mode of onset, clinical features and course, hæmolytic and infective lesions."

"Its features include the blood changes above mentioned in connection with 'septic anæmia,' generally more marked and of greater severity than in septic anæmia. They include, however, certain features which mark it off from simple septic anæmia. (*a*) An intense hæmolysis, accompanied by pigment changes in the liver, kidney and spleen—these changes being no less characteristically absent in 'septic anæmia,' even the severest forms. (*b*) A chronic septic infection associated with a specific glossitis and oral, gastric and intestinal sepsis."

In this anæmia Hunter does not consider that septic infection from the mouth or intestinal tract, however severe, can be held to be the direct cause of the disease. There is, however, often an antecedent history of oral, gastric or intestinal troubles, and he considers that they may play an important rôle in the onset of the disease.

(8) The Skin

In certain affections of the skin dental sepsis may be an etiological factor. In dealing with this question A. Whitfield[1] states that he only assumes a direct connection between the skin condition and dental sepsis when:

(*a*) A skin disease is either chronic or frequently recurring.

(*b*) No other cause can be found.

(*c*) The usual methods of treatment have proved of no avail.

(*d*) Treatment of the dental disease has been followed by a cure or marked improvement in the skin condition.

"The cases which have complied with these tests have belonged either to the **group containing purpura, erythema multiforme and lupus erythematosus or have been forms of eczematous dermatitis.**"

Acne rosacea is generally ascribed to digestive troubles. In many of these cases there is marked dental sepsis, and there is frequently no alleviation of the skin condition until the dental sepsis has been removed.

In **furuncles** (boils) there is evidence that the teeth are at times the source of infection. In a case which recently came under notice various forms of treatment had been tried with negative results. The teeth were then suspected and since their removal the condition has entirely disappeared. An interesting feature of the case was the "flare-up" of boils which followed the removal of each batch of teeth.

Alopecia areata was attributed by Jacquet to reflex irritation from the teeth or naso-pharynx; the fact that a regrowth of hair frequently follows the removal of foci of infection suggests that the cause is bacterial in origin. In many cases the focus of infection is in the mouth.

(9) The Nervous System

There is ample evidence that dental sepsis influences the course and development of many cases of nervous and mental disorders.

Cases of **neurasthenia** often show rapid improvement after treatment of the teeth. F. W. Brook[2] examined the fæces in forty-five cases of neurasthenia with the following results:—

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[1] "Some Points on the Etiology of Skin Diseases," *Lancet*, 1921, vol. ii, p. 168.

[2] *Brit. Med. Journ.*, October 12, 1912, p. 964.

B. coli	10	cases
S. pyogenes longus in practically pure culture	21	,,
B. coli + *S. pyogenes longus*	2	,,
Coliform bacilli in practically pure culture (This is probably an atypical strain of *B. coli*, and is by some authors considered to be causally related to muco-membranous colitis.)	6	,,
Coliform bacilli + *S. pyogenes longus*	3	,,
B. lactis aerogenes	3	,,

The chief point of interest was that in a large percentage of the streptococcal cases, periodontal disease was either present or, if not present, a definite history of it could be obtained.

In the majority of cases of neurasthenia there is a history of severe mental strain. The dental sepsis when present lowers the general resistance, including that of the nervous system, with the result that a mental strain which under normal conditions would be easily borne leads to nervous exhaustion when the resistance of the tissues has been lowered by sepsis.

That sepsis may influence the course of epilepsy is well demonstrated by a case which came under my notice. A man had been the subject of epilepsy for fifteen years, and had had as many as three fits in a day. There was extreme dental sepsis, which was treated and removed. At the end of a year he reported that the severe attacks had entirely ceased, but that occasionally he had a slight fit in his sleep, which was noticed by his wife, and that even these attacks were often separated by intervals of three weeks.

Certain writers would seem to attach undue importance to the dental sepsis as a causative factor in **mental affections.** H. A. Cotton,[1] for example, in referring to cases belonging to the dementia præcox group, considers that in 25 per cent. the teeth were the etiological factor. This author is perhaps inclined to underrate the influence of heredity—indeed, he expresses the view that heredity has very little influence on the etiology or prognosis of mental diseases; in other words, he would have us believe that the sepsis alone is responsible and that therefore with its removal a cure is effected and the prognosis is good as far as the mental condition is concerned. But we cannot ignore the considered opinion of so distinguished a neurologist as F. W. Mott, who emphasizes the importance of inborn factors in the production of neuroses and psychoses and certain degenerative conditions of the nervous system which have been designated under the collective term of abiotrophies. The nature of this inborn factor we do not know. It is probably an enfeebled resistance of the nerve cells to the action of certain toxins, and amongst these toxins we must include those of dental sepsis. The point on which I wish to lay stress is that the abnormal nervous condition in the majority of cases cannot be produced by the dental sepsis alone.

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[1] *Journal of Dental Research*, September, 1919.

(10) The Cardio-vascular System

In the Lumleian Lecture, 1899, Douglas Powell drew attention to a case of excessive cardiac irregularity which did not respond to treatment until the removal of the dental sepsis. Since that date our knowledge of the relation of septic teeth to certain cardiac conditions has been extended. T. Strickland Goodall has furnished me with the following notes on the cardio-vascular conditions in which dental sepsis sometimes plays a prominent part.

(*a*) *Certain Forms of Dry Pericarditis.*—The cases are associated with definite cardiac pain. Examination reveals a localized pericardial friction. There is no history of rheumatism or other recognized causes for the pericarditis, but a septic condition of the mouth is present. These cases are quite resistant to ordinary lines of treatment, but recover rapidly when the dental sepsis is treated.

(*b*) *Certain Cases of Aortic Regurgitation.*—(*i*) *Aortic regurgitation of specific origin* will progress steadfastly under strict anti-syphilitic treatment if the mouth is septic, but will improve to a marked extent if the mouth is freed from sepsis. (*ii*) *Aortic regurgitation with angina:* cases of most severe angina which fail to react appreciably to rest, vaso-dilators, or any of the usual remedies, will improve sufficiently to allow of a return to work, after removal of the dental sepsis.

(*c*) *Arteriosclerosis.*—This condition probably depends upon three main factors: (i) An inherited tendency (it is essentially a family disease). (ii) Increased intra-vascular strain. (iii) A septic focus. The eradication of the dental sepsis in these cases undoubtedly retards the progress of the disease, abolishes the associated arterial spasm and so frequently reduces the blood-pressure (i.e., intra-vascular strain).

(*d*) *Infective Endocarditis.*—The organisms identified with this condition are various and indicate that the disease is not due to any one special organism, but solely to pyogenic infection. There is evidence that the teeth may be the primary source of infection, as shown by the cultivation from the teeth of an organism identical with that obtained from the blood. W. H. Wynn[1] states that in fifteen cases of infective endocarditis in which he obtained a streptococcus from the blood, the organism in eight cases showed the characteristics of *S. salivarius*. In all the eight cases there was marked dental sepsis.

(*e*) *Cardiac Irregularity.*—Some of the irregularities associated with toxic conditions of the myocardium are probably profoundly influenced by the state of the teeth; but Goodall is not so certain on this point as he is of the part played by dental sepsis in the other conditions to which reference has been made.

(11) The Eye

Dental sepsis as a source of disease in the eye has been definitely established. Out of 215 cases of inflammatory conditions of the eye which W. Lang[2] attributed to sepsis, 129 were eventually traced to the teeth. He found also that the more vascular parts, the iris, the ciliary body, the choroid, were affected seven times more frequently than the less vascular sclerotic, retina and optic nerve, and in only one instance was the cornea primarily attacked. The pathology of eye lesions is in many cases still obscure, and it should only be assumed that a causal relationship exists between the teeth and the eyes when (*a*) the dental sepsis is the only apparent cause and (*b*) the eye condition clears up with the removal of the dental sepsis.

The following cases recorded by W. Lang[3] are instructive:—

Kerato-iritis with Vitreous Opacities and Secondary Glaucoma.—A man, aged 38, with normal vision $\frac{5}{5}$ in each eye, developed keratitis-punctata. Periodontal disease was present and several of the teeth most affected were removed. When seen one year later he could only count fingers at 2 ft. with the right, and at 1 ft. with the left eye. The vitreous was too hazy for the fundus to be seen. The tension was raised and the field of vision contracted in the right eye. The periodontal disease present was treated by extraction of all the teeth; the vision rapidly improved and three years later was $\frac{5}{5}$.

Central Choroiditis.—An officer of the Yeomanry who thought himself to be in good health, noticed two days before coming under observation a brown stain on the newspaper. On covering one eye he observed a blur which involved the fixation point; this was found to be due to a small patch of central choroiditis which had reduced the vision to $\frac{5}{6}$ slowly. Five days later the brown mist had reduced and the vision was $\frac{5}{5}$. In the interval three septic roots had been removed and his periodontitis treated.

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[1] *Brit. Dent. Journ.*, August 1, 1912.

[2] Supplement to *Proc. Roy. Soc. Med.*, May, 1913.

[3] *Lancet*, May 17, 1913, p. 1368, and private communication.

Disseminated Choroiditis.—In this patient disseminated choroiditis in one eye had reduced the vision in six months to $\frac{6}{60}$. She had all her teeth removed for periodontitis. In two days the vision was $\frac{6}{9}$; three weeks later it had gone back to $\frac{6}{24}$; a root which had been overlooked was removed the same day and within a few days the vision returned to $\frac{6}{9}$.

Operation for Senile Cataract.—A lady with a septic mouth which she refused to have treated before an operation for senile cataract, submitted to the removal of all her teeth when an iritis began to cause pain four days after the cataract had been extracted. The same day the pain in the head and eyes was less, and the inflammation ceased to increase; two days later the gums, which could not be cleaned up before the teeth were removed, were foul, and the eye was worse. In a few days the gums were clean and at the same time the eye improved and recovered very quickly and was well within three weeks. In similar cases where the source of sepsis is not removed, the eye remains inflamed for many weeks.

A case of *optic neuritis* associated with dental infection is recorded by H. W. Archer-Hall.[1] The patient complained of loss of vision in the right eye, and examination showed that visual acuity in this eye was reduced to perception of light and that with the left eye the patient saw $\frac{6}{12}$. Examination with the ophthalmoscope revealed a slight optic neuritis, not enough to account for the blindness, which seemed due to an inflammation of the optic nerve posterior to the eye, but extending forwards so that slight inflammation could be discerned at the optic disc. A carious tooth was removed with no effect, the patient becoming blind in both eyes. X-ray examination of the teeth revealed infection of bone around the apices of three teeth. Removal of the teeth was followed by progressive improvement and complete recovery within six weeks.

There is a difference of opinion as to whether many of the lesions are toxic or infective. A. W. Ormond[2] considers that there is no evidence that toxins alone are capable of producing a localized inflammation of the uvea, and is of the opinion that "all intractable cases of iritis and irido-cyclitis are due to the presence of microorganisms in the uveal tissue."

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[1] *Lancet,* April 1, 1922, p. 633.

[2] *Brit. Med. Journ.,* October 19, 1912, p. 1020.

(12) The Ear

A. J. Hutchinson[1] has recorded two cases which show that dental sepsis may influence the course of ear trouble.

In one case, a girl aged 18 years suffered from deafness and tinnitus in both ears. The membranes were normal. The hearing improved and the tinnitus ceased with the removal of five teeth affected with periodontal disease.

In another case, a man was attacked by pain in the ear after bathing; the pain continued for thirteen months and was accompanied by a varying amount of discharge. Subsequently he developed pain in the knee, elbow and neck. The periodontal disease present was treated by radical measures and the condition improved.

There is a condition in which the patient complains of a worrying feeling in the position of the external auditory meatus and examination of the ear shows no definite lesion. In a further stage the worry becomes a definite pain. Many of these cases are due to septic infection of the mandibular nerve, the condition rapidly clearing with the removal of the sepsis.

(13) General Infection

That general infection may result from lesions associated with the teeth is shown by cases which have been reported from time to time. The majority of these cases have been in connection with acute dento-alveolar suppuration.

The suppuration of a chronic character such as is seen in general periodontal disease (pyorrhœa alveolaris) must, however, also be regarded as a potential cause of general infection. A case of this type is recorded by G. Bellei,[2] and is instructive, as it demonstrates the sequence of events: (*a*) Suppurative periodontitis; (*b*) septic tonsillitis; (*c*) general infection.

The patient was a man, aged 48, who had been in good health until the age of 40 years, when he began to suffer from chronic inflammation of the gums and the maxillary alveoli, accompanied by the formation of pus. At the age of 45 years his right testicle was removed because it was found to be affected by tuberculosis. He made a good recovery after the operation, and, apart from his dental trouble, his health was satisfactory. One day he was attacked with a severe sore throat, which he did not treat in any way, but went to his business as usual. In the evening he had a violent fit of shivering followed by high temperature, and it was obvious that the sore throat and pyrexia were caused by a phlegmon of the pharynx. In the course of the next few days an abscess formed in the right tonsil. This abscess was opened four days after the beginning of the inflammation of the pharynx; a moderate quantity of pus escaped which, on cultivation, showed the presence of a very small streptococcus and of a saccharomyces. After the operation the patient felt very much better, the pain in his throat subsided, so that he became able to swallow, and his temperature, which had hitherto been about 100° F., fell to 98°. But about 7 a.m. next day he was suddenly seized with a shivering fit, followed by a rise of temperature to 104°. The suspicion of a general infection produced by one of the micro-organisms that had been found in the pus of the abscess was suspected, and with a view of confirming the diagnosis some blood was taken from a vein of his left arm. As it seemed probable that the infection was due to the streptococcus, the use of Marmorek's serum was begun in order not to lose time. In the first twenty-four hours 50 c.c. were injected, but the patient's condition grew worse, and his temperature remained permanently high, being always about 104°. The use of Marmorek's serum was continued during the next two days, but in spite of it the patient died from failure of the heart, unaccompanied by any localized lesion.

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[1] *Proc. Roy. Soc. Med.*, January 25, 1921, vol. xiv (Otological Sec.).

[2] *Lancet*, March 22, 1902.

The micro-organism isolated from the blood was a streptococcus, which had the same microscopical character as that found in the abscess.

(14) Intermittent Fever

There is a class of disease characterized by an irregular temperature of long duration to which no definite cause can be assigned. This condition may be regarded as a subacute septicæmia, and there is evidence that in some instances the teeth are the focus of infection as shown by the following case[1]: A male, aged 30, was admitted to hospital on July 11 with headache, pain in the back and slight cough. The temperature was 102·2° F.; the pulse-rate 98, and the respiration 24. There was no history of tropical disease. There was marked dental sepsis. Leucocytosis, 19,200. The case was regarded as one of light apical pneumonia. During the following two weeks the condition was as follows: "Intermittent fever had been present; the temperature had been at its highest (102-103·5° F.) almost every day at 6 p.m., and the pulse-rate had risen synchronously. The leucocyte count had varied between 20,000 and 24,800, the differential count always showing an increase of polymorphonuclear cells. The blood had been examined twice for organisms and on several occasions for the malaria parasite, always with negative results. Large doses of quinine had been given without any relief to the symptoms. The urine had been twice examined and was sterile. Slight general bronchitis had been present; repeated examinations of the sputum for the tubercle bacillus had been made with negative results."

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[1] Recorded by A. Abrahams, *Lancet.*

"During the first half of August the patient improved as regarded his temperature, but from the 14th onwards intermittent fever recurred, with increased pulse frequency and leucocytosis. He lost ground rapidly, and on August 25 his weight was only 9st. 12lb., having fallen from 10st. on August 4. Since his condition pointed beyond any doubt to some form of persistent sepsis, and since the most exhaustive examinations had failed to elicit the slightest clue to any other source, it seemed reasonable to incriminate the septic teeth. The patient, who had refused early in his illness to undergo dental treatment or to believe that his teeth, which 'had never ached in his life,' could be the cause of his trouble, now yielded more easily to fresh pressure, and on August 30 five carious roots were removed. On this day his temperature was 103° F., pulse-rate 116, and weight 9st. 10¾lb. On September 3 three teeth were extracted. The temperature remained intermittently raised as before until the 10th, and not a little doubt was cast upon the advantage of his dental experience. But on that day the temperature fell to 97° F., and for the rest of his stay in hospital (until October 2) it never rose above 98° F., the pulse-rate varying from 44 to 92. On September 20 the last seven offenders were extracted."

"More striking than the cessation of fever was the general improvement. As stated above, the weight on August 30 was 9st. 10¾lb. On September 16 it was 10st. 4lb.; on the 23rd, 10st. 8¾lb.; and on the 30th, 11st. The patient, despite obvious masticatory difficulty, complained that he could not get enough to eat."

A final point of interest was the leucocyte count. On August 22 it was 19,000; polymorphonuclears, 81·8 per cent. On September 10, 28,200; polymorphonuclears, 79 per cent. On the 16th, 19,200; polymorphonuclears, 71 per cent. (Temperature on this day, 97·4° F., pulse-rate 64.) On the 21st, 27,200; polymorphonuclears, 75·1 per cent. (Temperature on this day 97·8° F., pulse-rate 60.) On the 28th, 11,800; polymorphonuclears, 66 per cent. On October 2, 9,000. In other words, the polymorphonuclear leucocytosis persisted with gradual subsidence during the completely apyrexial period of his recovery.

An equally instructive case is recorded by C. W. Smith and H. E. Barnes in the *British Medical Journal*, September 18, 1909, p. 740.

(15) Cancer

Despite the great amount of thought and labour which has been expended upon research into this terrible malady, the cause still remains a mystery. There is abundant clinical evidence that the development of cancer is at times closely associated with chronic inflammatory processes. A. Paine,[1] the Director of the Cancer Hospital Research Institute, contends that cancer is but " a disordered growth of epithelium caused by various physical or chemical irritants, the most important being the toxins of micro-organisms." The cancer cell is a degenerate epithelial cell arising in the later or destructive stages of chronic inflammation. From this degenerate cell, " a cell that in some manner has been damaged or injured, the cancer cells are descended." " In this light, cancer appears as a terminal phase of inflammation and as a form of degeneration, in which sense, indeed, it was regarded by the older pathologists."

The close connection between chronic glossitis and sepsis has already been referred to on p. 685. Cancer of the breast is frequently preceded by chronic mastitis, and, in one section shown by A. Paine in his paper, all stages can be seen from the chronic inflamed cells to the cancer cells.

In the Mayos' clinic it was found that in 153 cases of gastric carcinoma there was naked-eye and microscopical evidence that the growth had developed in pre-existing ulcers.

Is there any reason to lead us to think that the toxins of dental sepsis may be a source of damage to the cell? The only work known to me that has any bearing on this subject was carried out by F. St. J. Steadman and reported by him to the last International Medical Congress. He examined 143 cases of cancer. The relative degree of dental sepsis (in these cases periodontal disease) is indicated by figures: (0) Entire absence of sepsis; (1) slight sepsis; (2) moderate sepsis; (3) advanced sepsis. Of these 143 cases, 118 had advanced sepsis, 19 moderate, 5 slight. If we take the maximum amount of sepsis which these 143 cases could have developed as 143 × 3 = 429 we find that the sepsis actually present represented 92·54 per cent. of the highest possible amount of sepsis. 415 persons over 35 years of age were examined as controls: of these, 66 had advanced, 123 moderate, 170 slight, 56 no sepsis. Taking the maximum amount of sepsis that these 415 persons could have developed as 415 × 3 = 1,245 we find that the amount actually present was 614, or 49 per cent. of the highest possible amount of sepsis. These figures show that there is a greater degree of dental sepsis in patients suffering from cancer than in those free from the disease.

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[1] *Lancet*, October 2, 1920, p. 693.

(C) GENERAL CONCLUSIONS

Sufficient evidence has been given on the preceding pages to show that dental sepsis has an influence upon the course and development of many pathological conditions. Speaking generally, it may be said that the course of all diseases may be influenced by oral conditions. Recovery from disease depends upon the reparative qualities of the tissues, and it is reasonable to assume that such reparative qualities must be very largely influenced by the quality of the substances absorbed from the whole intestinal tract. In acute illnesses, such as the exanthematous fevers, and conditions such as septicæmia and pneumonia, the prognosis must necessarily greatly depend upon the presence or absence of dental sepsis. Thus, it has been shown by W. Hunter that, in cases of scarlet fever, the severity of the mouth lesion and the duration of the disease are markedly influenced by septic conditions of the mouth. Again, in cases of diphtheria, the symptoms vary in intensity. The intensity may depend upon the relation of the individual resistance and the toxicity of the organisms, or it may depend upon a secondary or superadded infection. It is clear, therefore, that with a septic mouth severe forms of this disease are more likely to occur. Further, it is probable that dental sepsis, by chronically damaging the mucous membrane of the fauces, produces a favourable medium for the growth of the diphtheria organism.

The importance of dental sepsis in connection with acute pneumonia cannot be doubted. The fevered mucous membrane, the rapid breathing, the open mouth, the frequent expectoration, are in themselves sufficient to lead to unhealthy oral conditions; but if a pre-existing dental sepsis is added the condition of the patient becomes deplorable, and the prognosis infinitely less hopeful. With typhoid fever also the added sepsis must be of serious moment, and is possibly responsible for the recurring rises of temperature at times seen at the commencement of convalescence.

In common anæmias and many cases of malnutrition little or no improvement follows treatment by drugs, if dental sepsis is present; indeed, the removal of the dental trouble is often sufficient treatment.

It must not be forgotten that certain forms of chronic constipation are *dependent upon* a chronic colitis leading to excessive formation of mucus. The chronic colitis may be secondary to dental sepsis and be permanently incurable without removal of the dental trouble.

To quote the words of my brother, S. Colyer,[1] " The somewhat bizarre nature of the effects that have been attributed to dental sepsis may at first sight make the relationship appear improbable, overstated and even ridiculous; but when once the principles that underlie the subject have been grasped, it will be realized that the conclusions are a necessary outcome. In all diseases there are always two factors at least, the seed and the soil, without which disease cannot exist. The seed varies, the soil varies; never are the two the same; never is the relation repeated. This is why variation in disease occurs, and in no two persons does it run a precisely similar course. Dental sepsis, let it be repeated, is but a comprehensive term to include various forms of septic conditions of the teeth; it is not a disease. The germs causing the sepsis vary, and so the germs passing into the body, and the toxin absorbed, produce different results in different people. It cannot be said precisely why germs of a particular kind entering one body produce a septicæmia, and in another an infective endocarditis; or why a toxin in one will produce anæmia and in another a neuritis." An explanation may be forthcoming when we understand more thoroughly the part played by inborn factors in the production of disease and the selective affinity of micro-organisms or their toxins for certain groups of cells.[2]

It is not always easy to express an opinion in definite terms on the relation of dental sepsis to other pathological lesions. The first step must be to ascertain the degree of dental sepsis; and then the possibility of the existence of other sources of sepsis must be considered. If we are able to eliminate other sources of sepsis, then it is fair to assume that the lesion is due to dental sepsis, but even if other foci exist and are the probable sources of infection, the fact remains that dental sepsis may aggravate the condition by lowering the general vitality.

When the dental sepsis is associated as a cause with some other pathological condition, it is important that the facts should be fully and clearly explained to the patient, who should be told to what extent the mouth condition may be a direct or contributory cause of the condition. I desire to lay special stress on this because, at the present time, patients are often induced to part with their teeth on rash and unwarranted promises of a complete recovery from the general condition, whatever it may be, which is affecting their health. It must, however, always be kept in view that dental sepsis, if not at the time an active, is always a potential cause of disease, and for this reason alone removal of sepsis is a wise measure of precaution. Where caution is necessary is in expressing an opinion as to the direct responsibility of dental sepsis in the production of other diseases. There is a tendency to assume a causal relationship when dental sepsis is associated with a general condition—an association which may, after all, be purely accidental—without investigating and eliminating any other possible cause, and if this is done other and more insidious conditions that are at work may be overlooked to the detriment of the patient.

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[1] Concluding remarks to the chapter on " Oral Sepsis " in " The Science and Practice of Dental Surgery," by Norman Bennett.

[2] An interesting paper bearing on the selective affinity of micro-organisms was published by E. C. Rosenow in the *Journ. Nat. Dent. Assoc.*, November, 1919.

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CHAPTER XXVI

Diseases arising from Reflex Irritation from the Teeth

Affections of the Nervous System—Affections of the Ear—Affections of the Eye

In past years various lesions of the eye, ear and other organs were attributed to reflex irritation from the teeth. In reading the accounts of many of these cases, one is driven to the conclusion that the diagnosis was often incorrect, and that diseases which were merely coincident were frequently wrongly associated in a causal relationship. The histories of the cases, when read by the light of modern pathology, would suggest that, in the majority of the cases, the lesions attributed to the teeth were the result of septic absorption rather than reflex irritation.

(A) AFFECTIONS OF THE NERVOUS SYSTEM

Epileptic and Convulsive Seizures.[1]—It is possible that epilepsy may be induced by dental irritation. Brown Sequard found that, after section of one of the lateral columns of the cord anywhere between the medulla and the tenth dorsal vertebra, epilepsy could be induced by very slight irritation of the fifth nerve. The following case is recorded by Bakewski[2]:—

> "A young female had suffered from epileptic seizures for nine months, the fits having increased in frequency, there being several every day. The usual drugs were tried without effect. Finally, the teeth were examined and the maxillary right first molar and the mandibular left first molar were found to be carious. These were removed and the fits ceased entirely and did not return, the patient being kept under observation for six months subsequently. Upon being closely questioned, the girl remembered that before the fits commenced she had had some unpleasant sensations in the affected teeth, but nothing that could be described as pains."

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[1] The cases recorded under this and subsequent sub-headings have been introduced in order that the student may gain some idea of the evidence on which the relationship between reflex dental irritation and other diseases is based.

[2] *Journ. Brit. Dent. Assoc.*, vol. xii, p. 280.

A case of some interest came under the observation of Morton Smale:—

> "A patient, aged 22, a male, always showed distinct signs of *petit mal* during the operation of filling, the symptoms being always more marked if an exposed nerve were touched. This patient, to the best of his recollection, had never suffered at any time with epilepsy, nor had he had fits of any other character."

With persons subject to epilepsy it is not uncommon for a fit to be induced by the irritation attending dental operations.

Chorea.—Some medical writers are of opinion that chorea may in some instances be connected with dental irritation. Chorea is a functional condition, and it is possible that the dental lesion may induce chorea, either directly by reflex irritation or indirectly by lowering the vitality. The following case, quoted in the "American System of Dentistry," would seem to indicate that the dental trouble was intimately connected with the choreic condition. The case is related by C. N. Pierce[1]:—

> "A boy, aged 9, had always been in good health until two years ago, when he was attacked with choreic movements chiefly in the muscles of the face, though present also in the muscles of the neck and shoulders. Owing to their local character, and the absence of the causes usually assigned for the appearance of chorea, it was thought possible that the condition of the teeth might offer some explanation of the trouble. Careful examination of the mouth revealed, in addition to considerable overcrowding of the teeth, persistence of the deciduous incisors. Upon their removal the choreic movements at once subsided. After an interval of a year there was a return of the symptoms. Examination of the teeth again showed a persistence of the deciduous molars delaying the eruption of the premolars. Removal of the offending teeth was followed by complete recovery."

Spasmodic Closure of the Jaws.—The following case was reported by Ewart[2]:—

> "The patient, a man, aged 47, moderately addicted to alcohol, was suffering from an extensive chronic ulcer of the right leg. His illness began with a 'severe cold' three weeks before his admission into St. George's Hospital on September 20, 1899. The trismus set in quite suddenly during the night a week later, when he awoke in a fit of suffocation due to the closure of his lips unsupported by teeth. The same nocturnal attacks continued to occur in the hospital for five weeks. The rigidity of the jaws, of the floor of the mouth, of the platysma of the neck, and of the abdominal muscles was intensified by excitement, but there was neither opisthotonos nor any spasm of the limbs. Speech, respiration and alimentation were much impeded, leading to loss of flesh and weakness. There was a tender and slightly swollen spot on the gum, and the case was diagnosed from the first

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[1] Vol. iii, p. 598.

[2] *Brit. Journ. Dent. Sci.*, January 11, 1900.

as one of reflex spasm due to periosteal irritation and tenderness at the left posterior extremity of the upper jaw, and local treatment was recommended. This was finally resorted to, after various remedies had proved ineffectual, at the end of October, and the symptoms rapidly disappeared after the tender gum had been freely incised."

This case was probably purely reflex, the edentulous and healthy condition of the gums excluding the theory that septic infection from the mouth was the cause of the spasmodic closure of the jaws.

Many cases of so-called trismus arising from the teeth are not due to spasm of the masseter muscles as is usually supposed. The closure of the jaw in most of the cases arises from infiltration of the muscles and adjacent tissues, the interference with the movement of the jaw being due partly to mechanical impediment from the inflammatory products and partly to involuntary closing of the jaw.

Paralysis of the Arm.—In the chapter on odontalgia reference was made to the occurrence of pain in the arm, which was traceable to the teeth. It is interesting to note that cases of supposed paralysis of the arm have been recorded as due to dental lesions. Salter[1] records the following:—

"Miss B., aged 24, consulted me on October 15, 1864, respecting the left lower wisdom tooth, and the symptoms to which it had apparently given rise. The tooth had pierced the gum, but it was low down and placed horizontally, the crown pressing forwards against the second molar. The tooth was carious. From the first attempt at the eruption of this tooth there had been much pain of the ordinary kind about the angle of the jaw; latterly it had been intense, and for a fortnight there had been paralysis of the left arm; the patient complained of total inability to use the arm, to raise it or grasp with the hand; she could not employ the limb in dressing herself, and could not hold her fork at dinner. There was also a continuous pain of the whole arm resembling rheumatism. The tooth was extracted, but with extreme difficulty. As soon as the patient recovered from the pain of the operation she declared that the arm symptoms had vanished completely."

J. H. Mummery records[2] that whenever he suffered from much pain in a mandibular left molar he could raise his arm only with great difficulty and experienced a sense of weight and fatigue in the arm almost amounting to pain.

In Salter's case, as in many similar records, no electrical examination of the muscles could be recorded. Before arriving at a diagnosis of paralysis it is always advisable to exclude hysteria, and to satisfy oneself that the case is not one in which the part is involuntarily kept inactive in order to avoid pain.

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[1] "Dental Surgery and Pathology," p. 264.

[2] *Brit. Med. Journ.*, September 9, 1905.

Spasm of the Sternomastoid (Wry-neck).—A case of spasm of the sternomastoid has been recorded by Hancock.[1] The patient, a woman, had suffered considerable pain in the left shoulder, apparently owing to the presence of a carious tooth on the left side of the mandible. The head was drawn down almost to the left shoulder. On removal of the tooth the condition disappeared. In this case and in other similar cases recorded it is probable that the head was involuntarily bent down as a result of the pain and that there was no true spasm of the sternomastoid.

Tonic Spasm of the Upper Extremities.—In the following case the spasm of the muscles would seem to have been related to pulp irritation:—

> "A robust, strong man of 29, who was not in the least nervous, suffered from toothache, caused by an exposed pulp in the upper left third molar. During repeated attempts at luxation of the tooth, which was fixed very firmly, the forceps slid off and struck directly into the pulp. There was at once a tonic cramp of the flexor muscles of all fingers on both hands. Especially the left hand was closed so tightly that the patient could not open it, whilst he had some difficulty in opening the right. The flexibility of the arm was also affected. The patient, describing his condition, said he felt as though a very strong electric current passed through his head and arms, or as if the latter had pins and needles in them; a painful condition which caused the patient, usually showing great powers of endurance, to groan pitifully. Concentrated carbolic acid was applied to the pulp, whereupon the cramp gradually ceased. On the tooth being extracted the patient became normal, and could follow his business undisturbed all day long."[2]

(B) AFFECTIONS OF THE EAR

Affections of the ear due to reflex irritation from the teeth are uncommon. In many cases formerly attributed to reflex irritation from the teeth it is probable that a septic periodontitis was present, and it would seem more reasonable to regard the septic absorption from the teeth as a continuing cause which aggravates a condition originating from some other cause.

Otalgia.—Otalgia is frequently traceable to teeth. Politzer states[3] that carious teeth are the most frequent cause of otalgia in children. Otalgia unaccompanied by any inflammatory or other abnormal phenomenon in the ear itself which would account for the trouble, is invariably connected with the teeth, and in such cases the teeth should always be examined. Even when the ear symptoms appear to be sufficient to account for the otalgia the possibility that the condition of the teeth may aggravate the pain should not be overlooked.

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[1] *Lancet*, 1859, p. 80.

[2] This case was recorded by G. Randorf in *Items of Interest*.

[3] Edition, 1909, p. 686. Translated by Messrs. Baillie and Heller.

Deafness without definite lesions in the ear is at times apparently traceable to reflex trouble from an unerupted mandibular third molar. In a case under my care a patient developed what she termed a " worry " in the ear, which interfered with hearing. The ear was free from organic disease, and in the mouth the only possible cause of the trouble was an unerupted misplaced third molar. With the eruption and removal of this tooth the symptoms passed away. J. Howard Mummery[1] records a case of considerable deafness on the left side, which had existed for months in association with the delayed eruption of the maxillary third molar. The hearing was much relieved immediately after the extraction of the tooth and was fully restored the same day.

(C) AFFECTIONS OF THE EYE

Lachrymation.—Apart from an emotional flow of tears from the distressing pain of odontalgia, the eyes will occasionally become suffused with tears through sudden pain caused by biting on a sensitive tooth. This is similar to the reflex overflow of tears produced by pungent vapours, e.g., strong ammonia.

Spasm of the Orbicularis palpebrarum (Blepharospasm).—Excessive blinking is a mild variety of chronic spasms of the orbicular muscle of the eyelids. In a case of this kind seen by Knies, the spasms subsided immediately after the removal of a painful tooth.

Blepharospasm is occasionally traceable to reflex dental irritation, and in such instances the trouble can be cured by attention to the teeth. Blepharospasm may, however, occur in elderly, edentulous people, and a cure is then difficult, if not impossible. In these cases it is supposed that the osseous sclerosis present causes the spasms reflexly by the imprisonment of filaments of the dental nerve. The spasm involves, in addition to the orbicularis palpebrarum, many of the other muscles supplied by the facial nerve, and varies from a slight twitching of the orbicular muscle to a violent spasmodic contortion of the whole side of the face. Blepharospasm is usually asymmetrical, and is mostly seen in elderly females. It has no association with *tic convulsif*.

Strabismus.—A squint not infrequently develops during the period of the eruption of the deciduous molars, and many mothers are convinced that the dental irritation causes the squint. In these cases the disturbance created by the eruption of the teeth may act as the determining cause of the strabismus, the fundamental cause being either weakness of binocular vision, or disordered muscle balance co-ordination.

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[1] *Brit. Med. Journ.*, September 9, 1905, p. 553.

Spasm of Accommodation.—Spasmodic contraction of the ciliary muscle, similar to spasm of the internal rectus, seems occasionally to have a reflex dental origin. Attention to the teeth will sometimes cause a chronic ciliary spasm to relax, and thus cure a troublesome case of apparent myopia.

Paresis of the Levator Palpebræ Superioris.—Hancock[1] and Nicol[2] have each recorded a case of ptosis which disappeared after the treatment of carious teeth. In all probability the ptosis in these cases was purely functional.

Muscular Insufficiency with Diplopia has been attributed to painful carious teeth.

Paresis of Accommodation.—Accommodative failure, attended by asthenopia, is recognized by many surgeons to be due to diseases of the teeth. Schmidt[3] found it present in seventy-two out of ninety-two cases of dental caries. It probably results, as Knies[4] has suggested, from the lack of vigorous innervation brought about by the distressing pain. On the other hand, Priestley Smith found unimpaired accommodation in fifteen out of sixteen cases of odontalgia.

Amaurosis and Amblyopia.—Amaurosis, or complete functional loss of sight, and amblyopia or impaired visual acuity, are two functional conditions which have repeatedly been attributed to reflex dental irritation. There are many such cases on record. In some of them there was probably an acute retrobulbar optic neuritis, the result of inflammation by continuity of tissue, while in others the elements of hysteria probably predominated. Galezowski records a case in which a lady suffered from impaired vision after a tooth had been stopped; her vision improved on the removal of the filling and relapsed again when the tooth was refilled. The removal of the tooth wrought a permanent cure.

The following case of amaurosis consecutive to the extraction of a tooth is recorded by Santamaria (*La Stomatologia*, Milan, July, 1906).

The patient was a soldier who, prior to enlisting, had followed the occupation of portrait painter. Six months after his arrival at the Florence barracks he suffered from a violent attack of pulpitis in the upper right first molar, which tooth, being badly decayed, was extracted at once. A few hours after the extraction the patient again suffered from a neuralgic attack, the pain radiating from the right cheek to the eye of the same side, and from a rapid and progressive diminution in the visual power of the right eye, which very soon became amaurotic. This condition lasted five days, and, ceasing abruptly, was followed by intense amblyopia. An examination showed that the visual field had decreased both on the right and left sides, but to a greater extent on the former than on the latter, and that there was, in addition, an intense dichromatism for the blue and red primary colours. An external examination revealed nothing worthy of note; in the mouth no pathologic lesion could be seen.

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[1] *Lancet*, 1859, p. 80.

[2] *Trans. Odonto. Soc.*, November, 1895.

[3] *Arch. f. Ophthal.*, xiv, p. 107.

[4] "Relation of Diseases of the Eye to General Diseases," p. 267.

The author's conclusions regarding the peculiarities of this case are that the amblyopia was not of reflex nature; that the dichromatism was an interesting feature of the case by virtue of the previous occupation of the patient; that the amaurosis and the dichromatism confirm the fact observed by Trombetta, viz., that the symptoms exhibited by those affected with traumatic neurosis become in preference localized in those organs which for each patient are of pre-eminent importance in his daily occupation; that the nature of the traumatism was entirely out of proportion to the severity of the consecutive neurotic manifestations, and that even the most insignificant stimuli may be followed by serious and unexpected consequences in the case of neuropathic patients.

Glaucoma.—In referring to strabismus it was pointed out that the irritation from eruption might in some cases be the determining cause; in like manner it is possible that odontalgia may be the determining cause of a glaucoma. If an eye is anatomically in a condition favourable for the onset of an attack of glaucoma, severe pain arising from a carious tooth may so lower the vitality of the patient that the disease may be started. Von Hippel and Grünhagen[1] consider that irritation of the fifth nerve raises the intra-ocular pressure. Priestley Smith's[2] experiments, however, seem to show that the tension is not increased in odontalgia.

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[1] *Arch, f. Ophthal.*, xiv, 1, p. 107.

[2] Priestley Smith, "Glaucoma," London, 1879.

CHAPTER XXVII

The Operation of Extraction of the Teeth

The General Principles of Extraction—Extraction of Individual Teeth and Roots—Extraction of Misplaced Teeth—Extraction of Teeth under General Anæsthetics—Difficulties, Complications and Sequelæ of Extraction of Teeth

EXTRACTION is an operation which requires skill, judgment, experience, and an accurate anatomical knowledge of the parts involved. As with all other manipulative proceedings, success can only be attained by actual practice.

(A) GENERAL PRINCIPLES

The tooth to be removed should be carefully examined in order that the operator may gain some idea of the amount of sound tissue present and the degree of force which will be necessary to dislodge the tooth. In the case of roots the edges must be defined, and for this purpose a blunt probe will be found useful.

(1) Instruments

The instruments in general use for the removal of teeth are forceps and elevators.

The forceps is an amplified pair of pincers or pliers. It is made up of three parts, namely, the blades, or portions beyond the joint, which are applied to the tooth, the joint itself, and the handles. Forceps should be made of fine steel, light, and yet strong enough to withstand without bending any strain that it may be necessary to put upon them. Blades shaped to fit the tooth they are intended to remove should be used, and when applied they should be clear of the crown. On longitudinal section a blade should present a thin wedge-shaped appearance.

The handles should be of a size and shape to lie comfortably in the palm of the hand, and their relation to the blades should be such as to clear the lips when the blades are applied in the direction of the long axis of the tooth. For the anterior maxillary teeth the blades and handles should be in the same line (fig. 809); for the posterior maxillary teeth the blades should form a curve with the handles (fig. 810); for the mandibular teeth the blades should be bent down from the handles at an angle of ninety degrees (figs. 811 and 812).

The elevator consists of two parts—the handle and the blade. The handle is about four inches in length and of a shape suitable to allow a firm grip to be obtained. The blade is of fine steel and about two inches long. Elevators are either straight or curved. In the straight variety, the blade is thin, about one-fifth of an inch in breadth, one surface being made convex and the other flat; the point of the blade should be rounded as shown in fig. 816. In the curved variety, the terminal half-inch of the steel part of the instrument is bent at an angle with the shaft of the instrument (fig. 837). The edge of the blade of an elevator should always be kept sharp.

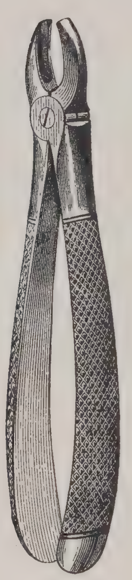

FIG. 809.[1]

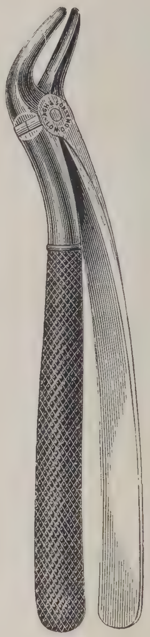

FIG. 810.

The screw (fig. 817) is an instrument which on rare occasions is useful for the removal of deep-seated roots.

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[1] For the use of the blocks illustrating the various instruments I am indebted to Messrs. Claudius Ash, Sons & Co.

(2) Method of Holding Instruments

Forceps should be held as shown in figs. 813 to 815. The handles should rest comfortably on the palmar surface of the hand, and in such a manner that the end of one handle rests between the thenar and hypothenar eminences—the part of the hand where force can be applied with the greatest advantage.

The thumb placed between the handles acts as a regulator to control the pressure of the blades upon the tooth. As a precaution it is well to have the ball of the thumb well between the handles, so that the pressure is counteracted by the terminal bony phalanx of the thumb as well as by the soft tissues. If this precaution be not observed, any sudden crushing of the tooth may be accompanied by a severe and very painful contusion of the operator's thumb.

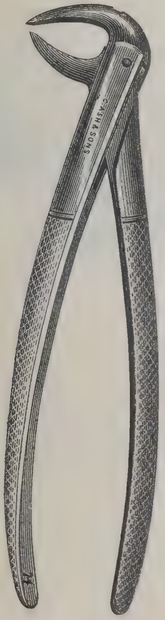

Fig. 811.

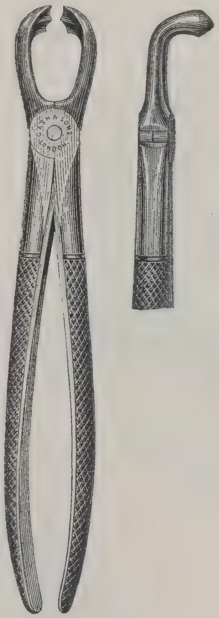

Fig. 812.

The method of holding an *elevator* is shown in fig. 818. The handle should rest comfortably in the hand, the first finger lying along the blade and being brought near the point so as to prevent the instrument from slipping. The first finger should lie along the curved side of the blade for extractions on the right side of the mandible, and along the flat side of the blade for extractions on the left side of the mandible

(3) Position of the Operator and the Patient

There should be a good light in front of the operating chair, and, if a proper dental chair is not available, an ordinary armchair may be utilized. The patient should be placed in an unconstrained position, but in such a position as will allow the operator all the freedom of movement which he may require.

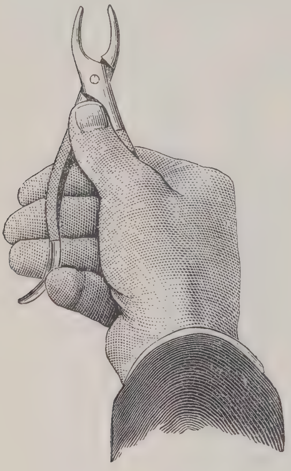

Fig. 813.—Mode of holding forceps for the removal of maxillary teeth.

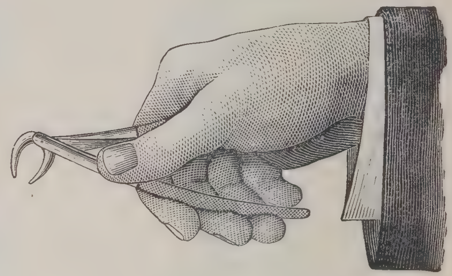

Fig. 814.—Mode of holding lower "hawk's bill" pattern forceps.

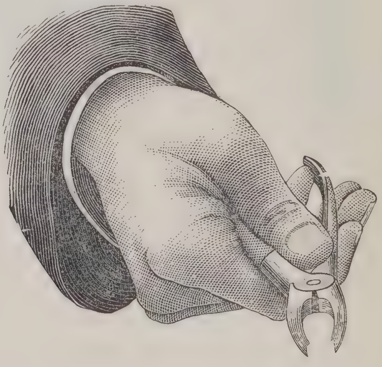

Fig. 815.—Mode of holding forceps of pattern shown in fig. 812.

The position of the operator should be such as to enable him to use force to the greatest advantage. His left arm may be utilized, if necessary, for steadying the movements of the patient's head, while the fingers of the left hand can be employed:—

(*a*) To control the cheek and other soft parts so as to obtain a clear view of the tooth to be extracted and its immediate neighbours.

(*b*) To support the mandible.

(*c*) To grasp the alveolar process in order to gain some idea of the effect of the force employed.

The special positions for the removal of different teeth are described on p. 730.

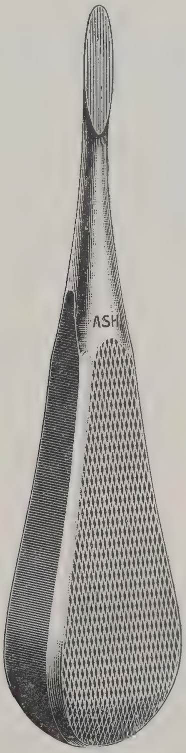

Fig. 816.

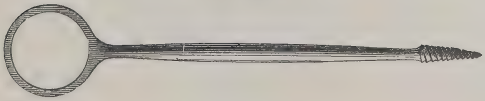

Fig. 817.

(4) Anatomy of the Teeth and Jaws

If the teeth be examined it will be noticed that as regards the roots they fall into three divisions:—

(*a*) Teeth with single, round, tapering roots.

(*b*) Teeth with single roots which are more or less irregularly flattened or curved.

(*c*) Teeth with multiple roots.

Division (*a*) comprises the maxillary incisors (deciduous and permanent), the mandibular premolars.

,, (*b*) The mandibular incisors and canines (deciduous and permanent), the maxillary canines (deciduous and permanent), the maxillary premolars.

,, (*c*) The maxillary and mandibular molars (deciduous and permanent).

The shape of the roots, as we shall subsequently find, has an important bearing upon the manner in which force is to be applied when severing the roots from their attachments. To ensure skilful and successful operations a thorough knowledge of the alveoli of the teeth is necessary, and it is needless to say that this knowledge can only be gained by careful study of the bones (fig. 819). Some idea of the strength of different portions of the alveolar border will thus be obtained, a matter of some moment when force is being applied in the process of removing a tooth from its socket. In the maxilla the points to be specially noted are the thinness of the outer alveolar wall as compared with the inner, and the prominence of the bone in the region of the third molar. In the mandible, the outer alveolar border is, it will be seen, thinner than the inner, with the exception of that portion in the region of the third and, often, of the second, molar; at the posterior portion of the socket of the third molar the bone is moderately dense.

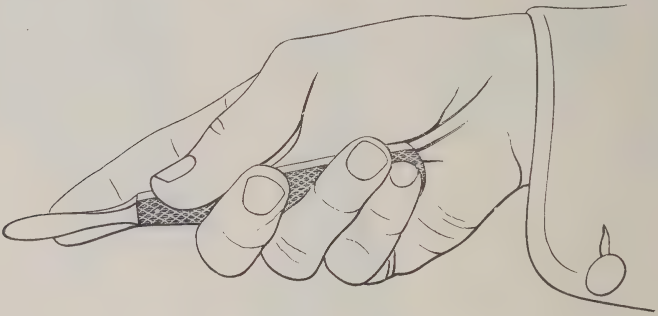

Fig. 818.

(5) Method of Using Instruments

The operation of tooth extraction when performed with forceps may be divided into three stages[1]:—

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[1] A description of the form of each tooth, with respect to its bearing upon the construction of forceps for its removal, will be found under the heading **B**.

(*a*) Adjustment of the forceps to the tooth.

(*b*) Destruction of the membranes connecting the tooth with the socket and dilatation of the socket.

(*c*) Removal of the tooth from the socket.

In the initial stage *the first step* is the application of the blades.

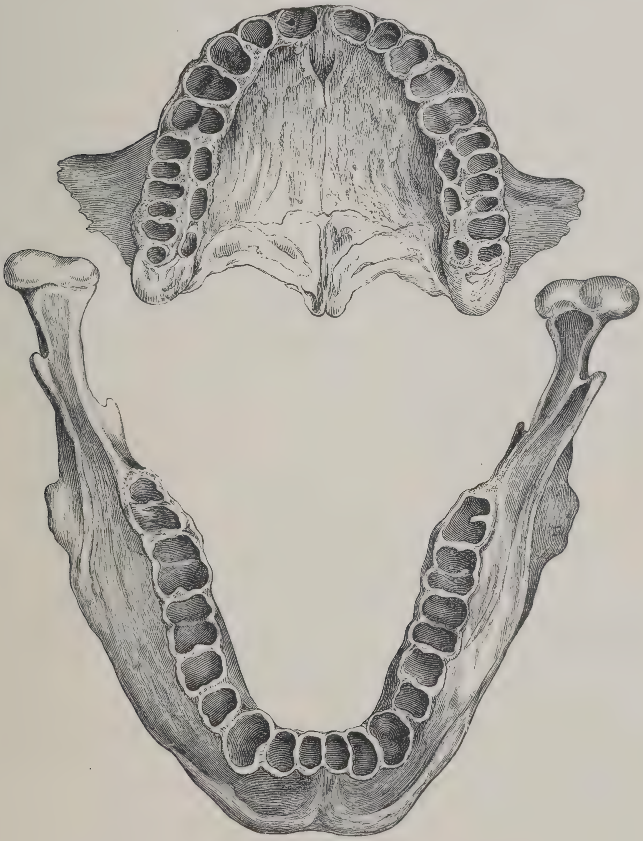

FIG. 819.[1]

Care must be taken that the points pass between the gum and the tooth, and also that the blades are applied parallel with the long axis of the root.

As a rule, it is best to apply one blade first on the side of the tooth most obscured from view, and then lightly to close the other upon the opposite side. The blades should then be forcibly pressed upwards or downwards, as the case may be, in the direction of the apex of the root; a slight rotary or wriggling motion will often be found of assistance in the process. This "pressing" movement should be continued until a firm hold of the root has been obtained—a matter of great importance, as the successful removal of the tooth depends in a large measure upon the grip obtained. The handles should next be closed so as to give the blades a firm grip, and the amount of pressure applied should be such that when movement has commenced the blades do not ride upon the surfaces of the root. The amount of pressure must of course depend upon the character of the tooth to be removed, and the resistance offered by the alveolar process. The thumb placed between the handles of the forceps, as already explained, should counteract the pressure on the root and prevent crushing.

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[1] From "The American System of Dentistry."

The second stage—the destruction of the membranous attachments and dilatation of the socket—is accomplished by employing force in either a rotary or a lateral direction. The movement to be employed depends upon the form of the root or roots to be removed and the resisting strength of the surrounding hard structures. Rotary movement is of course admissible only in the case of teeth possessing a single conical root.

The final stage is carried out by exerting extractive force in the direction of the long axis of the tooth, while at the same time following the line of least resistance; the latter is determined by a knowledge of the anatomy of the alveolar border and by the sensation conveyed to the hand through the forceps.

Elevators.—*The removal of a tooth with a straight elevator* is accomplished in the following manner:—

The blade, with the flattened surface towards the tooth to be removed, is inserted between the root and the alveolar process, the instrument being kept as far as possible parallel with the anterior surface of the crown. The blade is then forced downwards so as to reach the root at a point as low as possible; the handle of the elevator is then rotated away from the direction in which the tooth is to be removed. This has the effect of raising the tooth in its socket and at the same time displacing it in the required direction. One such movement of the instrument rarely suffices for the removal of a tooth, and a second, and sometimes a third grip, each time nearer the apex of the root, has to be obtained.

The method of using a *curved elevator* will be described in dealing with the removal of the roots of mandibular teeth.

The Screw.—Before attempting to remove a deep-seated root with the screw, a good view of the root should be obtained by pressing the overlying tissues away. A clear view of the root canal having been gained, the screw should be carefully worked into the canal, and when sufficient hold has been obtained extractive force should be applied.

(6) The Preparation of the Mouth

The tooth to be extracted should be freed from all foreign matter by the removal of any adherent salivary calculus and the thorough irrigation of the space around the tooth. For the purpose of irrigation peroxide of hydrogen is most useful, and the mouth should also be thoroughly rinsed with a suitable wash. The soft tissues around the tooth to be extracted should be swabbed with a 2 per cent. solution of iodine in alcohol. When many teeth have to be removed at one sitting every endeavour should be made to render the mouth as aseptic as possible before operating, especially in the case of patients suffering from periodontal disease. It is a good plan to prescribe a mouth-wash to be frequently used for at least one week before removing the teeth. The patient should also irrigate the individual sockets with a suitable antiseptic. By the removal of the sepsis in the mouth the resistance of the tissues is raised and they react more readily to the injury caused by the removal of the teeth.

(7) The Treatment of the Wound

The wound resulting from the removal of a tooth is a lacerated one. It is best treated by keeping the parts carefully cleansed from all foreign matter, and for this purpose an antiseptic mouth-wash[1] should be used several times a day. On the extraction of a maxillary tooth the discharge from the wound drains away naturally owing to the position of the orifice. The wound caused by the removal of a mandibular tooth cannot drain naturally and, should sepsis be present, the socket must be frequently syringed with some antiseptic solution.

The repair of the wound caused by the extraction of a tooth has never been carefully studied, but there is no reason to suppose that the process differs from that seen in the repair of other bones. The changes in the bone as seen in dried specimens are as follows:—

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[1] The following is a useful formula :—

℞ Liquoris potassæ ... ... ʒvi.
Acidi carbolici glacialis ... ... ʒiv.
Aquam ... ... ad ℥iv.

M. One teaspoonful to be used with half a tumblerful of warm water as a mouth-wash.

(1) The margins of the sockets undergo slight absorption (fig. 820, *a*).

(2) The wall of the socket is covered with a layer of fresh cancellous bone which gradually fills up the whole of the cavity (figs. 820, *b*, *c*, *d*).

(3) The compact layer forming the outside of the bone gradually spreads over this cancellous layer and eventually forms a complete cover (figs. 820, *e* and *f*).

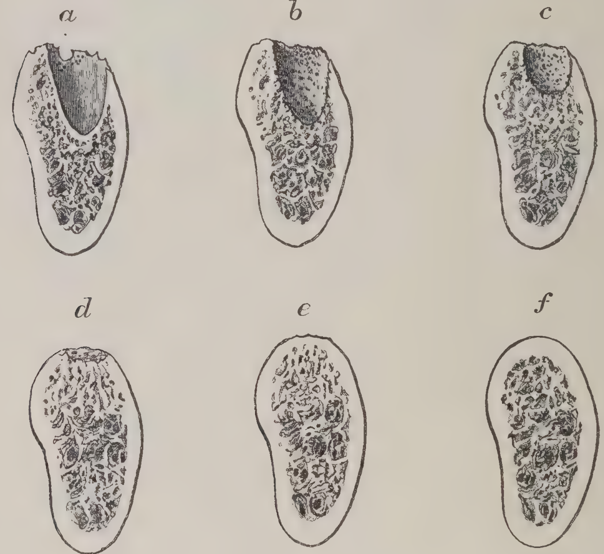

Fig. 820.

Where the bone around the teeth has been chronically inflamed, complete regeneration of the compact tissue does not always occur, and the surface of the bone remains of an irregular character.

The alveolar process is often splintered when extraction is difficult, and the sharp edges of the bone, which are often very painful, retard healing. It is advisable to remove these projections of bone with a pair of "nibbling" forceps, and for this purpose the instrument shown in fig. 821 is most useful.

In the case of molar teeth where the gum has receded the septum of bone between the roots may, after extraction of the teeth, project above the general level of the wound. The removal of the projecting bone will often expedite the healing of the wound.

(8) Extraction during the Menstrual Period

The extraction of teeth during menstruation should be avoided unless it becomes imperative in consequence of acute suppuration.

(9) Extraction of the Deciduous Teeth

Although the methods employed in the extraction of both deciduous and permanent teeth are alike in actual details, there are one or two points connected with the extraction of the deciduous teeth to which attention may with advantage be directed. First, when it is necessary to extract a child's tooth the child must be told. It is an unwise proceeding to deceive children in such matters or to take them unawares. The confidence and consent of children can generally be gained by the exercise of moral suasion after a little experience and practice.

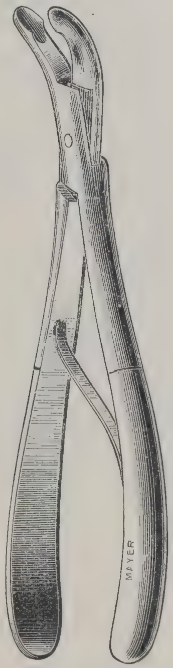

FIG. 821.[1]

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[1] These forceps are known as Jansen's Mastoid Gouge Forceps. For the use of this block I am indebted to Messrs. Mayer and Phelps.

(B) EXTRACTION OF INDIVIDUAL TEETH AND ROOTS

(1) Maxillary Teeth

For the removal of teeth in the maxilla the patient should be so placed as to allow the left arm of the operator to embrace the head of the patient with comfort if this is necessary. The operator should stand at the right side of the patient, and slightly in front, the first finger and thumb being placed on either side of the alveolar process (fig. 822). If the patient becomes restless, the arm should be moved so as to encircle the head and hold it firmly.

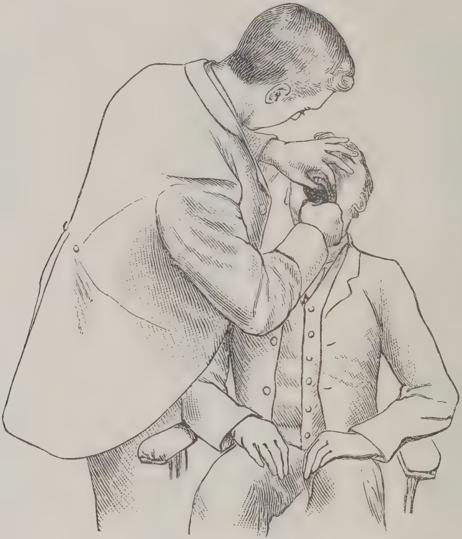

Fig. 822

(*a*) *Maxillary Incisors.*—The roots of the first and second incisors are usually cone-shaped, the anterior surface forming the arc of a larger circle than the posterior surface. Forceps for the removal of these teeth ought therefore to have the blades made to correspond to the surfaces. The second incisor is smaller than the first, and has at times a root somewhat flattened. In removing maxillary incisors the posterior blade is applied first, care being taken to see that the edge of the instrument passes between the gum and the tooth. To dislodge these teeth a firm inward movement should be made in a direction towards the palate, this movement being followed by one in an outward direction. If this fails to dislodge the tooth from its attachments, a firm rotary motion, first to the right and then to the left, may be tried (the amount of rotation necessary being only about an eighth of the circle represented by the circumference of the root).

It is usually recommended that, in the first instance, rotation should be tried for the extraction of these teeth, but the teeth yield more readily and with less laceration of the soft tissues if the inward movement is adopted.

The extraction of the roots of these teeth does not, as a rule, present much difficulty. When the roots are moderately sound the instrument shown in fig. 823 may be used, but where the root is much decayed and lies well below the gum margin, a rather finer pair will be found more serviceable. The manner of removal is similar to that adopted when the crown is standing.

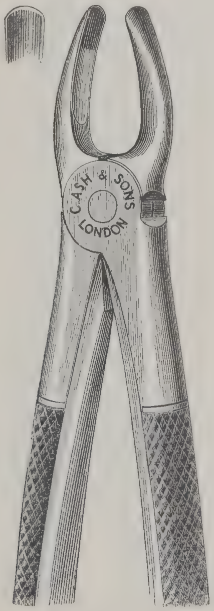

Fig. 823.

(*b*) *Canines.*—The canines are single rooted, like the incisors; but the difference between the curves of their anterior and posterior surfaces is greater than it is in the case of the incisors. Their roots, too, are much longer and more firmly implanted than the roots of the incisors, and more force is therefore necessary for the removal of the canines.

Forceps similar in pattern to those employed for incisors may be used, the severance of the tooth from its attachments being brought about by force applied in an inward, followed by an outward, direction. The root being more or less three-sided, rotation cannot well be adopted. The root of a canine tooth should be removed in the same manner as the whole tooth.

(*c*) *Premolars.—The first premolar* has usually one root flattened and more or less longitudinally grooved on its mesial and distal surfaces. If this grooving is very pronounced, the result is that the root is more or less divided into two slender terminations. The existence of such bifurcation can seldom be determined before operation, and would not alter the method of extraction, but the possibility of encountering this variation should be borne in mind and the lateral movement should be made very cautiously. The internal and external surfaces of the root are, for all practical purposes, equal in curvature.

The second premolar has usually only one root, which, in comparison with the root of the first premolar, is not so flattened in the antero-posterior diameter nor so grooved and bifurcated.

The blades of forceps for the premolars should be equal segments of the same circle; they should also be bent at such an angle with the handles as to allow the handles to clear the lower lip. The forceps shown in fig. 827 is a useful pattern. In removing a maxillary premolar, the inner blade of the forceps should be applied first. For severing the tooth from its attachments, a slight inward movement should first be made, followed by an outward. If the socket does not then yield, the inward movement may again be made and repeated if necessary. The removal of the tooth from its socket is to be carried out by force applied in a downward and outward direction. The removal of premolar roots is carried out in a similar manner.

For the removal of unerupted premolars see p. 238.

(*d*) *Molars.—The first molar* has three roots, one internal towards the palate (palatine), and two external (buccal). The palatine is the largest; subcylindrical in form, and often curved. The two buccal roots are placed one in an anterior and the other in a posterior position, the latter being in a plane internal to the anterior root; both are somewhat flattened; the anterior is the larger. The roots of the *second molar* are similar in shape to the first, but are usually smaller.

The third molar, when normal, has three roots, but very frequently these are all fused together and form an abrupt tapering cone, the point of which is often curved. Owing to the disposition of the roots, different forceps will be required for the removal of maxillary molars on the right and left sides. Of the blades, the outer or buccal should possess two grooves, the anterior being the broader and placed in a more external plane. This blade should also have a slight projection between the grooved surface for adaptation to the space between the buccal roots. The inner or palatal blade should possess only one groove. A well-made pair of upper molar forceps fits the neck of a maxillary first permanent molar perfectly. The blades should be bent at an angle with the handles, so that, when in use, the latter are clear of the lower lip (fig. 824). The palatine blade should be applied first, and in bringing the outer blade into place the point should be kept over the groove on the buccal side of the tooth, as this groove is a guide to the space between the outer roots. In order to sever these teeth from their attachments, force must be applied, first slightly inwards and then outwards, the movement being repeated if necessary, the removal of the tooth from the socket being carried out by exerting force in a downward and outward direction. Too much outward movement leads to undue bending or fracture of the external alveolar plate.

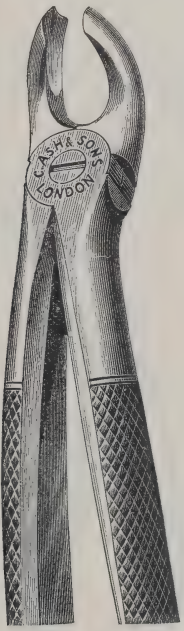

FIG. 824.

In removing the third molars the correct application of the forceps is of the utmost importance, as there is danger of including some of the soft tissue between the blades and the tooth and so causing a painful laceration. Force applied inwards, then outwards, is generally sufficient to loosen these teeth, their removal being carried out by a downward and outward movement.

Forceps similar to those in fig. 826 may be used for the removal of the third molars, but most operators use patterns with blades which are similar segments of the same circle. *There is an abnormality of the maxillary molars* which may with advantage be mentioned here. It consists in the posterior buccal root being situated in a plane much internal to the anterior root—in other words, it is an exaggeration of the normal arrangement. Such teeth are termed "*oblique-rooted*" (fig. 825). This abnormality is met with most frequently in the third molar, sometimes in the second, rarely in the first. The difficulty encountered in extracting these teeth is that the outer blade of the forceps is apt to slip round.

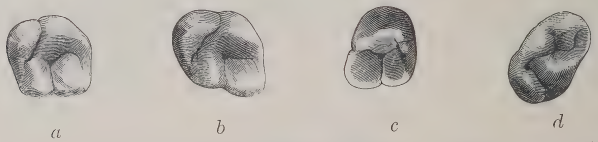

Fig. 825.—(*a*) normal maxillary first permanent molar; (*b*) oblique-rooted maxillary first permanent molar; (*c*) normal maxillary second permanent molar; (*d*) oblique-rooted second permanent molar.

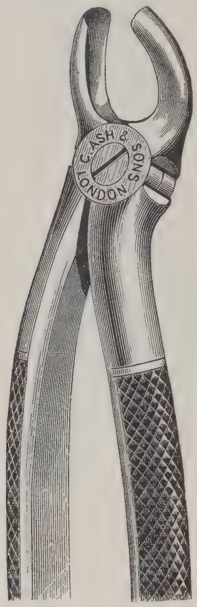

Fig. 826.

Oblique-rooted teeth can at times be diagnosed by noting an undue prominence of the alveolar process over the anterior buccal root; such teeth are best removed with forceps similar to that shown in fig. 826.

Where a portion of the crown remains and caries has extended well below the gum on either the palatal or buccal side, ordinary molar forceps should be discarded and root forceps employed; useful patterns are shown in figs. 827 and 828. The removal of teeth in this condition is carried out as follows: It will be supposed that the decay extends deeply on the palatine side. One blade of the forceps should first be applied to the buccal side of the tooth and to that root which is considered to be the stronger; the inner blade should then be applied to the palatine root, care being taken to insinuate it between the alveolus and the root. The forceps should be pushed well upwards until a firm hold of the root is obtained. A firm inward movement should then be made, as this will allow the inner blade to pass still higher up the palatine root and ensure steadiness should the blades tend to ride upon the surface of the root. An outward movement should next be made, but far less than that used

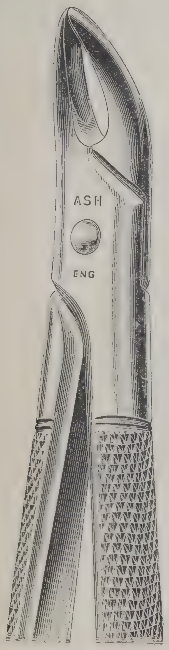

Fig. 827.

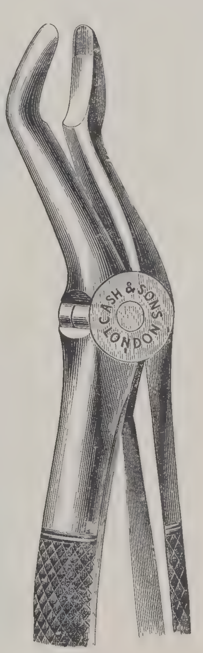

Fig. 828.

in extracting molars with the whole of the crown standing. This inward and outward movement is to be repeated until the tooth is free, the force being principally applied in the inward direction.

When the more extensive decay is on the buccal side the order of procedure is slightly different. The first blade to be applied should be the palatine, the outer blade being closed upon whichever of the buccal roots is considered the stronger. The extractive force should be applied first outwards and then inwards, these movements being repeated if necessary, the principal force being outwards, as the object in view is to prevent the instrument from slipping off the more decayed side.

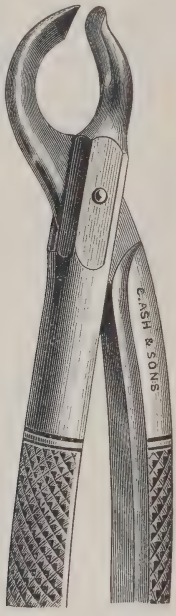

Fig. 829.

When a molar is so carious that very little of the crown remains, but all the roots are still united, root forceps should be used. The inner blade should be applied to the palatine root first, the outer blade being closed upon the stronger of the buccal roots. Inward, followed by outward, movement should be employed, the point to bear in mind being to use force towards the side of the tooth which is considered to be the weaker. Usually the three roots come away together, but if one or two roots remain they can be removed later without much difficulty.

Where the resistance presented by the roots is very great and an unsuccessful attempt at removal has been made with ordinary root forceps, an instrument with a buccal blade similar to that shown in fig. 829 may be used. The inner blade is applied first, the outer being inserted, if possible, into the space between the buccal roots. A firm hold of the roots having been gained, extraction should be attempted by force applied in an inward and outward direction; this failing, sufficient pressure should be put upon the handles to split the roots asunder. The sharp outer blade of the forceps will then pass between the buccal roots on to the palatine root, which can thus readily be brought away. A pair of ordinary upper root forceps should be employed to remove the buccal roots.

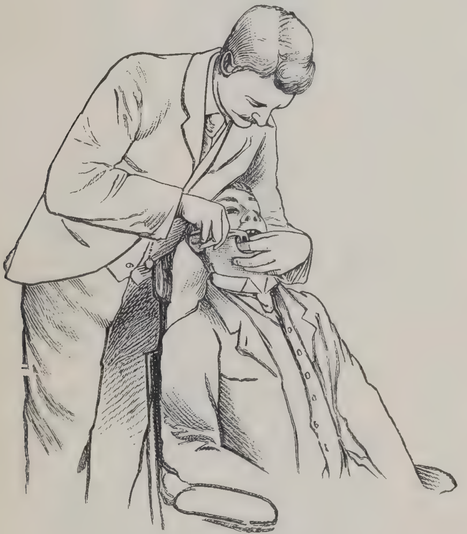

Fig. 830.

If all three roots of a molar are separate, a slight rotary movement will usually suffice for their removal.

Where there is danger of a molar fracturing, root forceps should be used in preference to ordinary forceps.

(2) Mandibular Teeth

For the removal of mandibular teeth the patient should be placed on a low level, the head being kept a little forward and the chin depressed. The position of the operator will depend upon the tooth to be removed and the instrument to be used. When hawk's bill pattern forceps or elevators are used for teeth on the right side, the operator should stand behind and to the right of the patient, the left arm being brought round the patient's head. The thumb of the left hand should be placed on the inside and the first finger on the outer side of the alveolar process of the tooth to be removed, and the three remaining fingers under and supporting the chin. In placing the fingers in the mouth, care should be taken to depress the wrist so as not to impede the entrance of light (fig. 830).

When removing the anterior teeth or those on the left side of the mouth, the operator should stand on the right side and slightly in front of the patient. The left hand should be placed as follows: the second finger on the lingual side, and the first on the labial side of the alveolar process of the tooth to be extracted, the thumb being placed under the chin (fig. 831). When employing forceps of the straight pattern shown in fig. 812, the operator should stand as shown in fig. 831, but it will be found difficult to place the fingers of the left hand on either side of the alveolus; indeed, they can only be used with advantage for retracting the cheek and supporting the mandible.

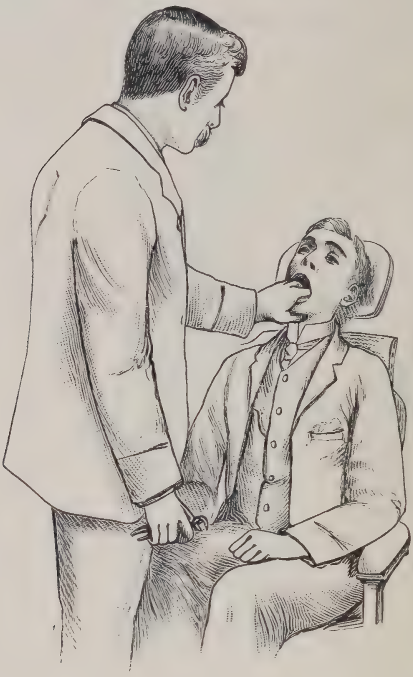

Fig. 831.

In removing teeth from the mandible, the operator should be careful to guard against the sudden separation of the tooth from its attachments when raising the tooth from its socket, as, unless the instrument is well under control, damage may be caused to the maxillary teeth.

(*a*) *Incisors.*—These teeth have each a single root, which is much flattened laterally. For their removal, forceps similar to those shown in fig. 832 should be used, the blades being equal segments of the same circle. The lingual blade should be applied first, the loosening movement being made by taking the tooth slightly inwards and then outwards, the final extractive force being upwards and outwards.

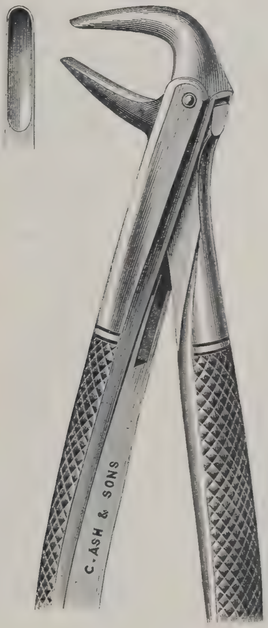

FIG. 832.

The removal of mandibular incisor roots is carried out in a similar manner.

(*b*) *Canines.*—The mandibular canines have normally one root, which is flattened laterally. It is stronger and longer than the incisor roots. The removal of a mandibular canine is carried out in a manner similar to that employed for the removal of a mandibular incisor, but as the canines present more resistance than the incisors greater force is usually required.

(*c*) *Premolars.*—The mandibular premolars have normally one root, which is conical in shape. The conical shape of the root is not so marked in the first premolar as in the second, the outer aspect forming the arc of rather a larger circle than the inner aspect. Forceps similar to those shown in fig. 811 may be used, the blades being practically equal in size and shape. The lingual blade of the instrument should be applied first, the tooth being severed from its attachments by a slight rotatory movement around the long axis of the tooth, first in one direction, then in the other; should this not suffice, a slight inward, followed by an outward, movement may be tried, the tooth being raised from its socket by force applied in an upward and slightly outward direction.

The roots of mandibular premolars should be removed in a manner similar to that required for the extraction of the whole tooth. When the root lies much below the level of the gum, the extraction is often troublesome owing to the difficulty in gaining a hold with the blades of the forceps; in such cases, if an attempt with forceps has failed, the straight elevator may be employed.

(*d*) *Molars*.—Mandibular molars have two roots, placed anteriorly and posteriorly. The roots are much flattened, and have a tendency to curve backwards, the curving being well marked in the second and still more so in the third molar; a fusion of the two roots is at times met with in the second and, frequently, in the third molar. A section of a mandibular molar at the neck shows both the buccal and lingual surfaces to be composed of two segments of a circle touching each other at one extremity, the anterior segment being slightly the larger (fig. 833). Each blade of the forceps used for these teeth should possess two grooves separated by a projection which fits into the division between the anterior and posterior roots; for all practical purposes the blades may be made of the same size, so that one instrument will suffice for both sides of the jaw. The instrument best adapted for the removal of these teeth is shown in fig. 834, though some operators prefer the shape illustrated in fig. 835. The advantages of the former over the latter may be briefly summed up as follows: (1) A clear view of the tooth and its surroundings can be obtained during the whole period of removal; (2) force can be applied with greater advantage; (3) the alveolar process can be easily embraced by the fingers, or by the finger and thumb of the left hand.

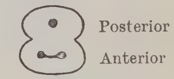

FIG. 833.

One disadvantage of the shape shown in fig. 834 is the difficulty of employing much inward movement, and therefore, for teeth lying inwards, that is, with the crown directed towards the tongue, hawk's-bill shaped forceps cannot be easily used. Another disadvantage is that the extent of inward movement is limited by the proximity of the maxillary teeth, and, in case of trismus, it is often better to use straight forceps.

In removing mandibular molars with forceps, the inner blade should be applied first and then the outer, care being taken to get the points of the blades between the interspaces of the roots. For severing these teeth from their attachments, a slight inward movement should be made first, followed by a movement well outwards, these inward and outward movements being repeated if necessary. The removal of the tooth from its socket is carried out by force used in an upward and outward direction. The upward force exerted upon mandibular teeth should always be well under control, as, not infrequently, the resistance is overcome very suddenly, and without such precaution there is danger of forcibly striking the maxillary teeth. As previously pointed out, the roots of these teeth are at times curved a little backwards, and it is often needful, in removing the teeth from their sockets, to twist the forceps in a curved direction backwards.

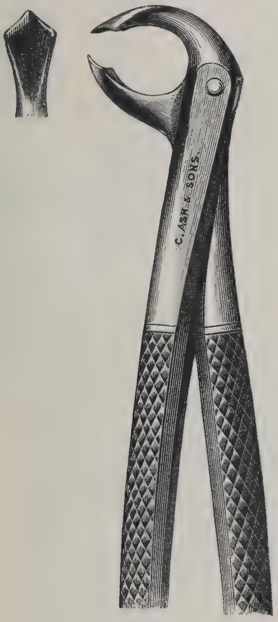

Fig. 834.

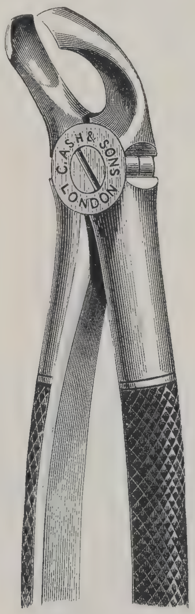

Fig. 835.

In the *removal of the second molar*, too much outward movement is to be avoided, as the outer alveolar process is often very dense.

The third molar is best removed with a straight elevator. A glance at the illustration of this tooth (fig. 836) will show that the roots have a well-marked curve backwards, in addition to which the bone forming the socket of this tooth is stronger than is the case with the anterior molars. The removal of the third molar has therefore to be accomplished by using force in a direction upwards and backwards, in other words, in the curve following the arc of the circle formed by the roots. This movement cannot well be carried out with forceps, but is easily accomplished with the elevator as follows (it being assumed that the second molar is in place): Hold the elevator as shown in fig. 818, and insert the blade between the anterior surface of the root and the alveolar process, keeping the flattened side of the instrument as far as possible parallel with the root surface. Then force the blade downwards towards the apex of the root and rotate the handle away from the direction in which the tooth is to be moved. This has the effect of raising the tooth in its socket and at the same time displacing it backwards. (The edge of the elevator which is to be brought into contact with the surface of the root should be sharp so as to cut somewhat into the cement.) If this movement is not effective the handle should

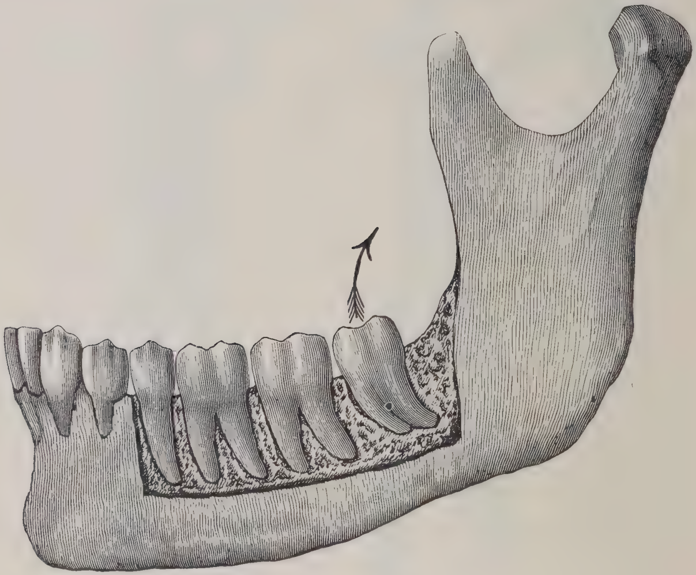

Fig. 836.

again be raised and the flattened end of the instrument brought parallel with the anterior surface of the root, the extractive movement being repeated until the tooth is completely raised from its socket. In using the elevator, special care must be taken to protect the tongue with the thumb or the fingers of the left hand, so as to provide against the instrument slipping and penetrating the tongue.

With the third molar there is a tendency for the gum to adhere tenaciously to the posterior aspect of the neck of the tooth. When this happens it is better simply to raise the tooth from its socket with the elevator or forceps, as the case may be, and then cut the gum away with a curved pair of scissors. By this method a severe laceration of the gum may at times be avoided.

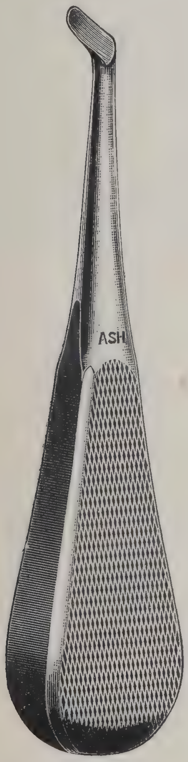

Fig. 837.

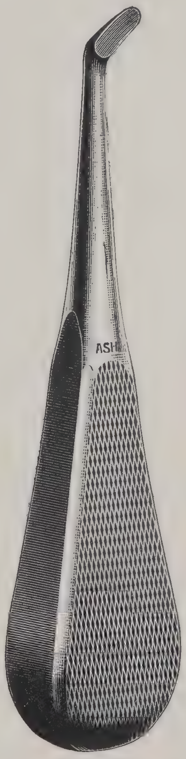

Fig. 838.

When the third molar is isolated owing to the absence of the second molar, the elevator may still be employed for its removal, the first finger of the left hand being used as a fulcrum on the right side and the thumb on the left side. In such cases many operators prefer to use ordinary lower molar forceps.

The removal of mandibular molars when a portion of the crown is standing, but the caries has progressed below the gum on either the buccal or lingual aspect, is carried out with root forceps of shape shown in fig. 811. A similar condition in maxillary molars and the method of their removal was referred to on p. 735. The principles there enunciated apply to the removal of the mandibular molars. The main points to bear in mind are to apply the blades of the forceps to the stronger root, and to use the principal force in the direction of the weaker wall.

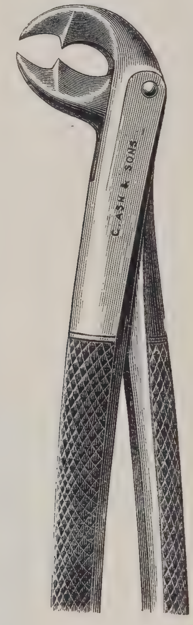

Fig. 839.

Where the roots of molars are still united, root forceps should be used, the blade being first applied to the lingual surface of the stronger root. A firm hold having been obtained, the root may be removed by employing force in the same way as with ordinary molar forceps. Both roots will usually come away together. If only one root is extracted, the remaining root can easily be removed with the same forceps or with a curved elevator (figs. 837 and 838). The curved elevator should be insinuated between the root and the alveolar process so as to force the tooth into the empty socket, or the elevator may be placed in the empty socket and the root elevated by forcing the point through the septum of bone.

With roots of mandibular molars which present great resistance, forceps with cutting blades may be used (fig. 839). The blades are inserted on the lingual and buccal aspects of the roots in such a manner that the points pass into the space between the roots. The handles are then closed and an attempt is made to remove the roots in the ordinary way, but, should this prove unsuccessful, the handles must be forcibly closed so as to divide the roots, which can then, as a rule, be removed with ordinary root forceps.

The advantage of splitting roots in a case similar to that shown in fig. 840 is apparent, as each root can then be removed in the line of its inclination.

Where the roots are separated their removal is carried out with root forceps, an inward and outward movement being usually sufficient. The roots of third molars are best removed with a straight elevator. The *modus operandi* is similar to that used in extracting the whole tooth.

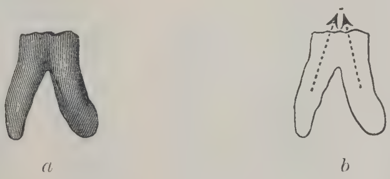

FIG. 840.—(*a*) mandibular molar with divergent roots; (*b*) the dotted lines show the direction in which the roots can be removed if the tooth is divided as suggested in the text.

At times the mandibular molar teeth are tilted so that the crown surfaces stand towards the tongue. Their removal is best carried out with instruments of the pattern shown in fig. 812, as the handles of forceps of the hawk's-bill pattern would come in contact with the maxillary teeth and impede the inward movement which is so necessary for the removal of teeth in this position.

(3) Deciduous Teeth

For the removal of maxillary incisors and canines, a small pair of straight forceps of the pattern shown in fig. 841 should be used. The first deciduous molars are best removed with a pair of forceps like fig. 842.

The mandibular incisors and canines require a small pair of hawk's-bill forceps similar to the shape shown in fig. 832. For the deciduous molars a small pair of forceps similar to that illustrated in fig. 834 should be used.

In removing deciduous teeth, care must be taken not to drive the forceps too high up or the permanent teeth may be injured, and this danger should be specially guarded against in the case of the deciduous molars, as the roots of these teeth practically embrace the crowns of the premolars.

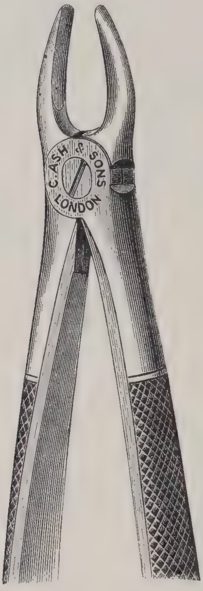

Fig. 841.

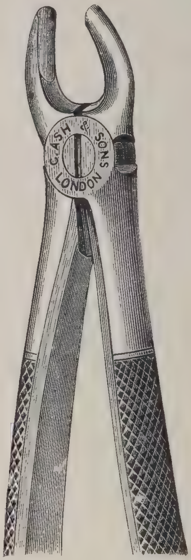

Fig. 842.

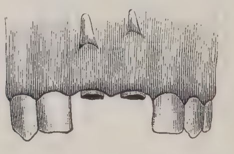

Fig. 843[1]

Roots in the condition shown in fig. 843 are best removed with an elevator as follows: The thumb of the right hand being placed on an adjacent tooth so as to gain a hold, the point of the elevator is placed below the end of the root and pressure applied. In a few cases it may be necessary to cut the gum with a lancet before using the elevator. For the small pieces of the deciduous teeth which persist and become wedged in between the permanent teeth, the small curved elevators will be found useful.

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[1] From "Dental Surgery and Pathology," by A. Coleman.

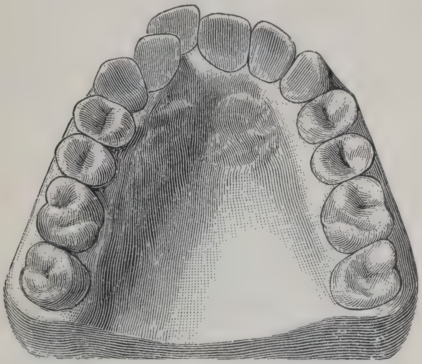

Fig. 844.

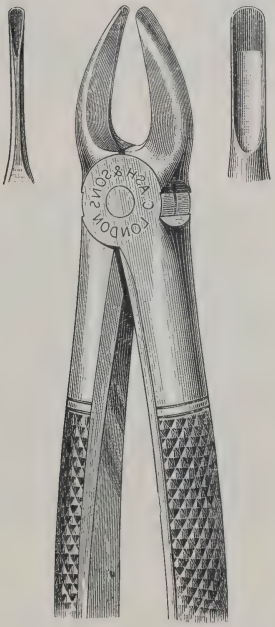

Fig. 845.

(C) THE EXTRACTION OF MISPLACED TEETH

The extraction of a misplaced or impacted tooth is perhaps the greatest test of the skill of an operator, and although it is impossible to give a complete list of the various malpositions met with, those most commonly seen will be mentioned and the usual method of removing such teeth indicated.

(1) Maxillary Teeth

(*a*) *First Incisors.*—The extraction of an irregularly placed incisor such as is shown in fig. 844, which is the seat of intractable chronic periodontitis, is best carried out with an instrument similar to that shown in fig. 845, the fine inner blade being applied on the palatal side and the broad blade on the labial. Extractive force should be applied principally in the outward direction, and, if this is not sufficient, slight rotary movement should be tried. Where there is less room between the approximal teeth, the projecting tooth may be removed with a pair of straight forceps (fig. 823), the blades being applied to the mesial and distal aspects of the root.

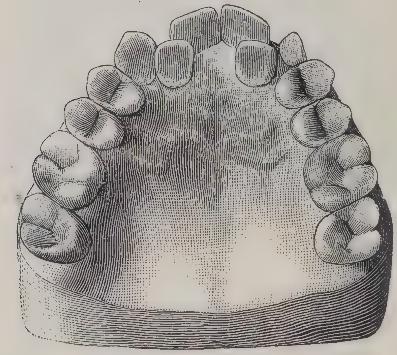
FIG. 846.

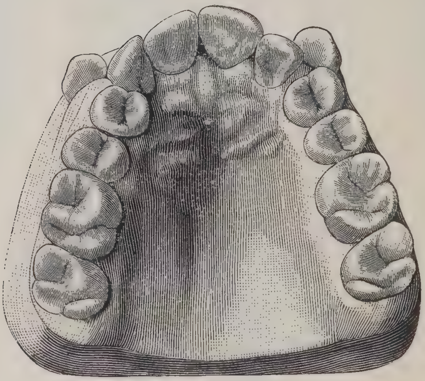
FIG. 847.

The blades should not be driven very far up, and the loosening of the tooth should be accomplished by slight rotary motion, but care should be taken to avoid loosening the approximal teeth.

(*b*) *Second incisors* lying internal to the arch, see fig. 846, can be removed with the forceps shown in fig. 845, by placing the fine blade on the labial and the broad blade on the palatal side of the tooth. Extractive movement should be made inwards, followed by very slight outward movement; this failing, rotation should be tried, but, as pointed out on a previous page, this form of movement is not so suitable for second as for first incisors.

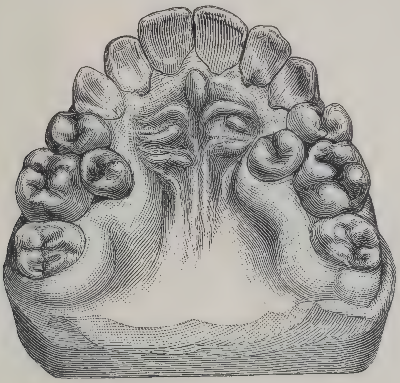

FIG. 848.

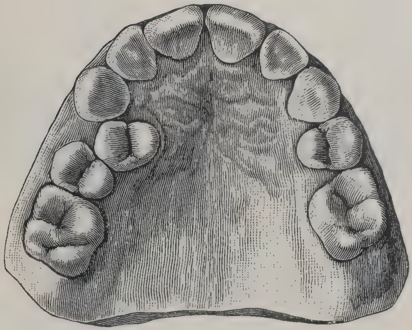

FIG. 849.

(*c*) *Canines* placed high in the arch, as shown in fig. 847, may be extracted with a straight pair of forceps (fig. 823), the blades being placed on the mesial and labial aspects of the root. Extraction of such teeth is very difficult. Slight but firm rotation may first be tried; if this fails to loosen the tooth, slight lateral movement may be attempted, the force being applied towards, and then away from, the median line of the mouth.

(*d*) *Premolars* misplaced, as shown in fig. 848, can be removed with forceps similar to those depicted in fig. 827, the blades being applied on the anterior and posterior aspects of the tooth. Force should be applied in a backward and forward direction, the movements being repeated alternately until the tooth is loosened in its socket. A premolar placed as shown in fig. 849 can be removed with forceps similar in form to those depicted in fig. 827, with the outer blade strong but narrow. The extractive movement should be made mainly in an inward direction.

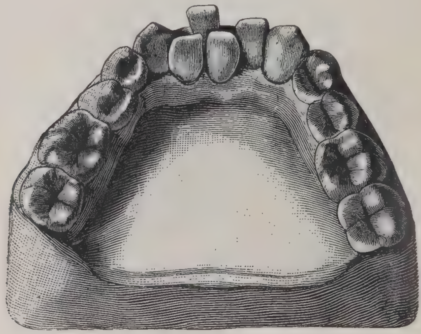

Fig. 850.

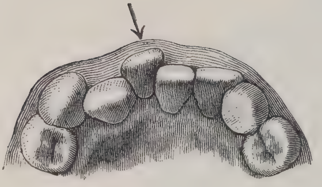

Fig. 851.

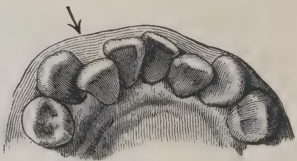

Fig. 852.

(2) Mandibular Teeth

(*a*) *Incisors* misplaced, as shown in fig. 850, may be removed with ordinary lower root forceps (hawk's bill pattern), the blades being placed on the mesial and distal surfaces of the root and movement applied in a direction towards and away from the median line of the mouth. When the crowding is not severe (fig. 851), forceps of the hawk's bill pattern with a strong but narrow inner blade should be used (fig. 853), and the principal extractive movement made in an outward direction. For an incisor placed as shown in fig. 852, the narrow blade should be the outer one (fig. 854), and the principal force should be applied in an inward direction.

(*b*) *Premolars* placed as shown in fig. 855 are most difficult to remove. One of the most useful instruments for their extraction is a pair of upper root forceps (Read's pattern, fig. 827), which should be held so that the curve of the blades is downwards. The blades should grasp the root on its anterior and posterior surfaces.

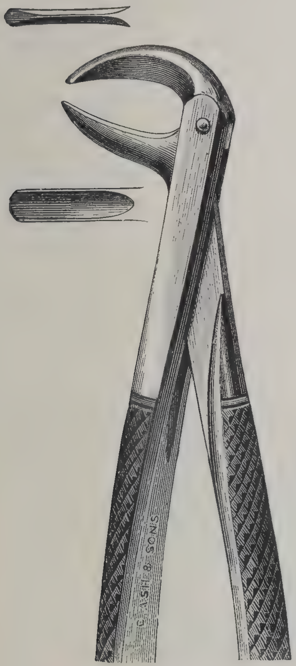

Fig. 853.

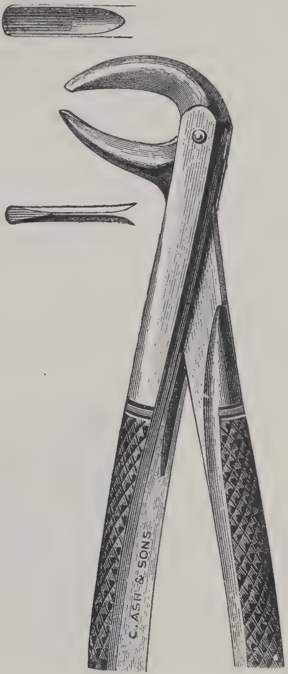

Fig. 854.

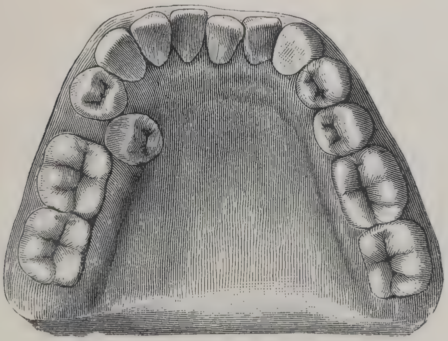

Fig. 855.

Slight rotary movement may first be attempted, followed by lateral motion. These movements should be continued until the tooth is found to yield. The application of too much force may lead to a fracture which would be extremely difficult to deal with.

Where the crowding is not very marked and the tooth is more in the normal line of the arch, a forceps with a narrow outer blade will suffice (fig. 854). Extractive force should be used principally towards the median line of the mouth, and this may be combined with slight rotary movement.

(c) *Third molars* when *partially erupted or misplaced* are amongst the most difficult teeth to extract. The position of the misplaced tooth may amount only to a slight tilt forwards, or the tooth may be placed horizontally, the occluding surface of the crown impinging on the posterior root of the second molar. In some instances the tooth may be so placed that the occluding surface looks downwards and inwards. An examination of specimens showing misplaced mandibular molars (figs. 188 to 191) shows: (1) That the roots of these teeth are to some extent covered by the ramus of the mandible; (2) that the root of the tooth is in close proximity to the mandibular canal; and (3) that only a small amount of bone exists at the posterior aspect of the second molar.

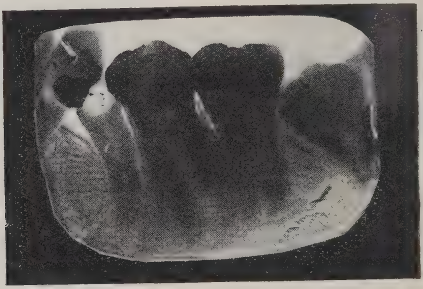

FIG. 856.

Wherever there is reason to expect difficulty in removing third molars, a radiogram should be obtained in order to ascertain the relation of the tooth to its surroundings.

When the tooth is in a normal direction, but retarded in erupting through want of room in the arch, it is a good plan, before attempting removal, to cut away the overlying gum in order to obtain as clear a view of the tooth as possible. Where the tooth is slightly tilted, the curved elevator will often be found a useful instrument for removal; the blade of this instrument can usually be inserted under the crown and the tooth prised upwards. Where the tooth is firmly embedded in the bone, the muco-periosteum covering the alveolar process should be raised and the bone surrounding the tooth cut away before removal is attempted. The wound left after the removal of the tooth should be syringed regularly until healing is complete. Attempts to remove such teeth by placing a curved elevator under them and forcibly prising them upwards invariably lead to failure, and may, if too much force is used, lead to fracture of the jaw.

(3) Embedded Roots

Roots occasionally become embedded and impacted and a good example of this is shown in fig. 856. The radiogram depicts a mandibular second premolar impacted between the first premolar and first molar. In cases of this character it is always advisable to obtain a radiogram, and a careful study of it will often be of considerable assistance in deciding upon the method to pursue in attempting removal of these roots. For example, the radiogram seen in fig. 856 shows that the embedded root lies close to the first molar and is separated by a considerable interval from the first premolar. The best instrument for the removal of these roots is a straight elevator, the roots being forced towards the direction of least resistance. In the case described above the elevator should be inserted between the root and the first molar, and the root elevated towards the first premolar.

Roots lying well below the surface of the bone can often be quite easily removed by means of the screw (fig. 817). The overlying soft tissues should be cut away and the screw worked into the pulp canal of the root until a secure hold is obtained, and then extractive movements applied.

(D) THE EXTRACTION OF TEETH UNDER GENERAL ANÆSTHETICS

Nitrous Oxide.—For most operations nitrous oxide should be chosen. Provided that asphyxia is avoided nitrous oxide is absolutely safe and has therefore a great advantage over ether and chloroform. Nitrous oxide can be more quickly administered than either ether or chloroform, and the recovery is rapid and complete. The modern practice of administering oxygen or air with nitrous oxide possesses the following distinct advantages over nitrous oxide used alone:—

(i) The danger of asphyxia is lessened.

(ii) The anæsthesia is quieter.

(iii) The congestion of the mucous membrane is lessened, and the operator therefore gains a clearer view of the tooth.

The "nasal method" for the administration of nitrous oxide has been extensively adopted during recent years. By this method the anæsthesia can in some cases be prolonged indefinitely. The nasal method of administering nitrous oxide has advantages over such anæsthetics as ethyl chloride and ether, but considerable experience and skill are required in the administration; too often an asphyxial rather than a true anæsthetic state is produced. The nasal method is suitable for cases where several loose teeth are to be extracted or where a little extra time is required for the removal of one or two difficult teeth. For powerfully built alcoholics the nasal method is not suitable, and a better result can be obtained by the use of nitrous oxide and oxygen given by the face-piece method.

Ethyl chloride.—For operations requiring one or two minutes anæsthesia, ethyl chloride is a useful agent, especially for children when it is necessary to remove several teeth. It is, however, a dangerous anæsthetic in inexperienced hands.

Ether.—This agent should be employed where a long period of anæsthesia is required. If the patient is thoroughly anæsthetized a period of ten to fifteen minutes anæsthesia can be obtained. The mucous secretion, which is one of the disadvantages in the use of ether in mouth operations, can be lessened by the administration, half an hour before the operation, of an injection in the case of men of morphia $\frac{1}{4}$ gr., atropin $\frac{1}{120}$ gr., in the case of women of morphia $\frac{1}{6}$ gr., atropin $\frac{1}{150}$ gr.

Chloroform.—The employment of this agent in dental surgery is seldom necessary. It is at all times a dangerous anæsthetic and especially for operations in the mouth. A few anæsthetists advocate the administration of chloroform for dental operations in the sitting posture, but the general consensus of opinion favours the horizontal position.

Whenever a general anæsthetic is given for the removal of teeth two persons should always be present, one to concentrate his attention on the administration of the anæsthetic, the other, on the removal of the teeth. This rule should be strictly adhered to. It is impossible for one person to operate and at the same time observe the condition of the patient during the anæsthetic period.

The Preparation of the Patient.—The last meal should be taken at least three hours before the administration of an anæsthetic and the meal should be of a light character. The position of the patient during the induction of anæsthesia and whilst under its influence should differ but little, if at all, from those already advocated for teeth extraction, except that the head should not be placed so far back. All tight clothing must be loosened, dentures removed from the mouth, and care taken to avoid any word or action likely to alarm the patient before and during the induction of anæsthesia. The operator should always decide beforehand precisely what he intends to undertake, and it is wise not to attempt too much. Care should be taken to avoid pricking the gum during the examination of any roots which are to be extracted. *The prop should be placed on sound firm teeth* in such a position that the operator can work without hindrance, and when the preparations are complete a final view of the mouth should be taken. The prop should be adjusted by the operator as he will know to what extent the mouth must be opened, but at the same time the anæsthetist should see that the position of the prop is not likely to obstruct respiration. *Where several teeth have to be extracted* at one sitting, their order of removal should be decided upon before the operation is commenced, and, if any particular tooth is causing pain, it should be extracted first. As far as possible the *order of removal* should be arranged so that changes of instruments are reduced to a minimum. As a rule mandibular teeth should be extracted before maxillary teeth, because if the latter are removed first the blood may pass down and so obscure the mandibular ones. For the same reason roots should be removed before whole teeth. *Each tooth or root must be cleared from the mouth before any attempt is made to remove another*, unless the gum is thoroughly adherent, when the tooth or root may be left in the mouth and freed from the gum when the patient has recovered.

Special precautions must be taken to prevent the entrance into the air passages of any foreign body. A sponge, or the corner of a napkin, should be used for this purpose; they can usually be adjusted in such a way as to give a clear view of the teeth to be removed.

During the operation of extraction, the anæsthetist should—

(i) Hold the head firmly with his hand on the forehead and his shoulder against the patient's head in order to prevent over-extension of the head, in which position there is danger of foreign bodies passing into the air passages;

(ii) Protect the lower lip from being pinched between the handles of the forceps and the mandibular teeth—a contingency which is very likely to occur when the head is over-extended; and

(iii) Clear away any blood which interferes with the operator's view.

When several teeth are to be removed on both sides of the mouth, it will be found useful to remove the maxillary and mandibular teeth on one side first, and then to cover the wounds with pledgets of wool, which should be held in place with the " Mason " gag. By this means the hæmorrhage is held in check during the operation on the opposite side of the mouth.

It has been observed that in extensive dental operations students are inclined to operate with blood flowing freely over the roots that require extraction. Such a practice invariably leads to undue laceration of the gums, and considerably retards the healing of the wounds.

The methods of employing local anæsthetics for the extraction of teeth are described in Chapter XXXVI.

(E) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ OF EXTRACTION OF THE TEETH

(1) Difficulties, Complications and Sequelæ connected with the Teeth themselves

(*a*) *Undue Resistance of the Teeth and Alveolar Process.*—Certain teeth offer more than ordinary resistance to removal. The teeth of persons of strong physique are nearly always very firmly fixed. Isolated teeth also are always more firmly fixed than those in series, a circumstance which is due to the consolidation of the surrounding bone. With experience and observation the teeth which are likely to be specially resistant can to some extent be recognized. When undue resistance is encountered, steady and repeated attempts should be made to free the tooth by moving it slightly in different directions; too much force used in one direction would be certain to fracture the tooth or the alveolar process. It may even be found impossible to remove a tooth, in which case it is advisable to dismiss the patient and make an attempt two or three days later, when the tooth will probably be loose as a result of the inflammatory process set up by the previous attempts at extraction, and it can then be easily removed.

The causes of undue resistance are:—

(i) Abnormal density of the alveolar process.

(ii) Divergent and twisted roots.

(iii) Alteration in the shapes of the roots brought about by periodontal inflammation.

(*b*) *Fracture of the Tooth.*—The principal causes of this accident are:—

(i) The use of forceps which do not accurately fit the tooth.

(ii) The use of unnecessary or wrongly applied force in an attempt to loosen the tooth in its socket.

If a tooth has been fractured, the patient should be made to rinse the mouth until the bleeding has ceased; the socket should be dried with cotton-wool, and the position and edge of the root defined with a probe before an attempt is made to remove the fractured portion. Neglect of these steps often leads to failure to remove the remaining portion of a fractured root. As a general rule more than two attempts to remove a fractured root should not be made at one sitting, and if the second attempt prove fruitless, the patient should be dismissed and a fresh attempt made after a period of one or two days, as the tooth will probably then be looser; moreover, the hæmorrhage will have ceased and it will be possible to obtain a clearer view of the root. Before dismissing the patient an anodyne mouth-wash should be prescribed, and the pulp, if exposed, touched with a strong escharotic. The lower third of a root may generally be left without fear of harm; but it is always advisable to inform the patient when any portion of a tooth is allowed to remain in the jaw, as such knowledge may be of assistance should any trouble arise at a subsequent date.

(*c*) *Crowded and Irregular Teeth.*—The removal of these has already been referred to on p. 747.

(*d*) *The Removal of the Wrong Tooth.*—Should the operator accidentally remove the wrong tooth, it must be immediately replaced and, if necessary, secured with a ligature. If the pulp subsequently shows signs of degeneration or inflammation, it should be removed and the canal treated and filled.

(*e*) *Dislocation of a Neighbouring Tooth.*—This accident, which is generally due to a crowded arrangement of the teeth, seems to occur most frequently with the removal of the mandibular first permanent molar, the neighbouring tooth usually involved being the second premolar, which is simultaneously dislocated from its socket. To avoid this contingency the thumb should be placed on the tooth which shows a tendency to move, and in the removal of the tooth which is being extracted only as much force should be exerted as can be controlled by the thumb. If a neighbouring tooth is removed, it must be replaced and treated in the manner described above.

(*f*) *Removal of an Unerupted Premolar.*—This may be an avoidable or an unavoidable accident. At times the developing premolar is so firmly embraced by the roots of the deciduous molar that, during the extraction of the latter tooth, the premolar is removed; such an accident cannot be avoided. It is an avoidable accident when it occurs through using too much force in the extraction of the roots of a deciduous molar.

In quite young children the tooth sac of the premolar may be so firmly attached to the deciduous molar that its removal is unavoidable.

(*g*) *Breaking One Tooth in Extracting Another.*—In the extraction of mandibular teeth with hawk's bill forceps a maxillary tooth may be fractured. This accident, which is generally due to inexperience, is caused by the tooth which is being extracted suddenly leaving its socket in consequence of force being used in an upward rather than an outward direction. It may, however, occur when a mandibular tooth has been more than normally resistant. It is well, therefore, for the operator to be on guard by keeping the thumb or a finger of the left hand over the joint of the forceps. An adjacent tooth may also be fractured in using the elevator.

(2) Difficulties, Complications and Sequelæ connected with the Jaws

(*a*) *Fracture.*—Accidental fracture and removal of a *small piece of the alveolar process* is not uncommon, but the result is not serious. It is sometimes unavoidable, but it may be due to placing the blades of the forceps on the outer side of the bone instead of between the bone and the root of the tooth.

Extensive fracture is sometimes seen; for instance, in a case that came under notice at the Royal Dental Hospital, an unqualified person in removing the mandibular right first permanent molar fractured the bone in a horizontal direction, so that the second and first premolars with the canine were completely separated from the body of the bone. Fracture of the maxillary tuberosity may occur during the removal of the third molar, and Main Nicol[1] records such an accident during the removal of the second permanent molar. An example of severe fracture is recorded by Cattlin,[2] where, in an attempt to remove a maxillary third molar with an elevator, the tuberosity of the maxilla, a portion of the floor of the maxillary sinus and part of the sphenoid were fractured. Direct transverse fracture of the body of the mandible due to extraction of the teeth has also been recorded. This accident is most likely to occur during the removal of misplaced mandibular third molars.

(*b*) *Necrosis* of the alveolar process may result from extraction and is generally caused by undue violence or by the occurrence in the wound of some septic process. For treatment see Chapter XXX.

(*c*) *Dislocation of the Temporo-mandibular Articulation.*—The use of too much force in extracting a mandibular tooth may lead to unilateral or bilateral dislocation of the temporo-mandibular articulation, if the force is not counteracted. This accident may also be brought about by forcing open the mouth too wide with a Mason's gag during the administration of an anæsthetic. Or it may occur without the employment of undue force where the articulation has been previously dislocated. Dislocation of the jaw can easily be reduced by placing the thumbs on the molar teeth, the fingers being placed beneath the chin. A downward movement is to be used with the thumbs and an upward with the fingers. It is well to wrap some lint or a towel round the thumbs to prevent them being injured. If necessary, the leverage can be increased by placing corks or some similar wedge between the molars.

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[1] *Trans. Odonto. Soc.*, vol. xxviii, p. 3.

[2] *Ibid.*, vol. iii, p. 138.

(*d*) *Opening the Maxillary Sinus.*—This accident may occur during the removal of the maxillary molars, or, occasionally, the second premolar, and may be due to a portion of the floor of the cavity adhering to the teeth, or to the fact that the root of the tooth has only been separated from the sinus by its lining membrane which has been torn away during extraction. The condition is recognized by epistaxis and by fluid passing from the mouth into the nasal fossa viâ the sinus. The condition usually does not call for treatment unless the opening persists, a circumstance which is extremely rare.

(*e*) *Forcing a Root into the Maxillary Sinus.*—This occurs mostly in connection with the extraction of the maxillary second premolar root and the buccal roots of the first permanent molar. If a root has been dislocated into the cavity but partly remains in its socket, it should be left alone, as any attempt to remove it might only result in complete dislocation of the root into the sinus. The socket should be kept quite clean by the continual use of antiseptic washes. When a root has been forced completely into the maxillary sinus, the opening into the sinus should be enlarged and the cavity thoroughly syringed. For this purpose it is well to use an aural syringe of 5 or 6 oz. capacity. The *rationale* of this form of treatment is that the root may pass out with the return current from the sinus. If this treatment fails, free access to the cavity must be gained by an opening through the canine fossa, when the tooth can be removed.

(*f*) *Forcing a Tooth into an Abscess Cavity.*—This accident should be treated in the same way as the accident under (*e*).

(*g*) *Trismus.*—Inability to open the mouth obviously renders extraction of the teeth more difficult than usual. When the closure is the result of inflammatory trouble in connection with the lower molars, an anæsthetic should be given and the mouth opened forcibly with a Mason's gag. If the trismus is the result of tonic contraction of the muscles, ether should be used in order to overcome the resistance of the muscles, as nitrous oxide would not have the desired effect.

(3) Difficulties, Complications and Sequelæ connected with the Soft Tissues

(*a*) *Extensive Laceration of the Gum.*—The soft tissues naturally suffer when a tooth has been difficult to remove, and may be severely lacerated when the gum attachment to the tooth is unusually tenacious. Extensive laceration occurs most frequently in connection with the removal of the mandibular third molar, but it may occur in connection with the removal of loose teeth. When the gum is more than usually adherent, the tooth should be left in the socket until the gum attachment has been divided with a pair of scissors, or with a lancet. Continued attempts to remove the tooth with the forceps before the gum has been detached will only increase the laceration. Where the gums have been badly lacerated, an anodyne mouth-wash should be prescribed.

(*b*) *Wounding the Tongue.*—This is most likely to occur under nitrous oxide, as the tongue during anæsthesia is generally swollen, and is, moreover, not under the control of the patient. Wounding of the tongue is nearly always due to carelessness in the use of the elevator. When the tongue is much lacerated, the overhanging portions should be trimmed off with scissors and the surface kept clean with antiseptic mouth-washes.

If the tongue is punctured and the wound does not involve a large branch of the lingual artery, but yet bleeds freely, the tongue should be drawn forward; if this does not stop the bleeding the insertion of a stitch will generally cause the hæmorrhage to cease.

If the tongue is punctured and a large branch of the lingual artery is involved, the finger should be placed on the back of the tongue and the organ drawn forward, thus compressing the lingual artery against the hyoid bone. The bleeding point must then be sought for, and, if found, an attempt should be made to twist the wounded vessel. If this fails, cauterization may be tried, and, as a last resource, if cauterization does not stop the bleeding, the lingual artery must be tied.

(*c*) *Bruising the Lower Lips.*—This may occur in the removal of premolars and molars, and is due to the mouth being insufficiently opened, and to the use of forceps of too straight a pattern.

(*d*) *Injury of the Mandibular Nerve.*—The mandibular nerve at times runs in close proximity to the roots of the third molar and may be injured during the extraction of that tooth. Occasionally the nerve pierces the roots of the third molar, and extraction of the tooth then tears the nerve asunder. Montagu F. Hopson possesses a specimen in which the nerve pierced the root of the second premolar. Loss of sensation over the parts supplied by the nerve, with dribbling saliva, generally follows the accident, but sensation is usually restored and if the nerve is lacerated it generally re-unites. On the other hand, there may be no loss of sensation and the pain may be intense.

(*e*) *Suppuration of the Tooth Socket.*—Suppuration in the wound caused by extraction is invariably due to neglect of proper precautions. It is more likely to occur where the vitality of the tissues in the vicinity of the tooth has been lowered; for example, in cases of chronic periodontitis, or where there is a lowered general vitality, as seen in such conditions as diabetes, chronic nephritis and tuberculosis.

Suppuration of the wound may be due to direct infection either from septic foci in the mouth or from the inhalation of air laden with infectious organisms. Suppuration from the latter cause is frequently met with in those constantly working in hospital.

Where the pus is putrid and there is reason to suspect infection, the socket should be thoroughly syringed with some antiseptic, such as carbolic acid 1 in 40, and the parts should be carefully dried with cotton-wool. A small piece of chloride of zinc should then be introduced and allowed to dissolve in the socket, which must be subsequently kept aseptic by constant irrigation with some antiseptic solution. Suppuration occurs more frequently in the mandible than in the maxilla, the drainage of the maxilla being more easily effected owing to the dependent position of the sockets. When suppuration occurs in patients of diminished vitality a tonic form of treatment should be prescribed.

(*f*) *Persistent hæmorrhage following tooth extraction* is a serious complication, and one which needs prompt treatment. Persistent hæmorrhage may be due to:—

(1) Pathological changes in the artery which supplies the tooth, these changes being frequently induced by inflammation around the apex of the root, the vessel becoming adherent to its bony surroundings and thus being prevented from contracting.

(2) A defect in the process of fibrin formation. Fibrin is formed by the action of the fibrin ferment (thrombin) on the fibrinogen contained in the plasma. The formation of thrombin is brought about by the action of a ferment (thrombokinase) on prothrombin,

the presence of calcium salts being necessary. The formation of fibrin can therefore be expressed as follows:—

(1) Prothrombin (thrombogen) + Thrombokinase (from + Calcium salts
(? from leucocytes) damaged leucocytes (in plasma)
or tissue cells)

Thrombin (fibrin ferment)

(2) Thrombin + Fibrinogen (in plasma)

Fibrin

Liability to hæmorrhage is characteristic of certain general conditions, i.e., leucocythæmia, polycythæmia, pernicious anæmia, scurvy, purpura, *hæmophilia*. The last-named condition is inherited by the male through the female parent, and is probably due to a defect in the quality of the prothrombin. The blood of hæmophiliacs is said to show no abnormality in the quantity of calcium salts, but it is clinically established that the administration of calcium salts is beneficial, and this fact rather suggests that there is some defect in the calcium content of the blood. It is stated[1] that true hæmophilia does not occur in woman. Many people not true hæmophiliacs show a tendency to hæmorrhage.

Bleeding is more liable to follow the extraction of teeth for periodontal disease than for other conditions, and it is possible that this is due to a chronic arteritis of the apical vessels.

Secondary hæmorrhage is due to sepsis of the tooth socket.

Treatment.—If the hæmorrhage following tooth extraction is at all profuse, it is a useful plan to give the patient some tincture of hamamelis in the water used for rinsing the mouth. Should the bleeding continue, an examination must be made to ascertain (1) whether the bleeding emanates from the gum or from the socket of the tooth; (2) whether the blood shows a tendency to coagulate. If the blood coagulates readily it is probable that the hæmorrhage is due to some condition which prevents the natural contraction of the vessels. If the blood does not coagulate readily the hæmorrhage is probably due to some defect in the process of fibrin formation.

If the hæmorrhage is from the gum, search should be made for any small vessels that may be the cause of it, and, if found, they should be twisted or compressed. If the vessel is only partially divided, it should be completely severed, as this will probably allow contraction to take place. If the bleeding is capillary in character, a pad of lint applied with firm pressure is usually sufficient to stop it, and a method which is efficacious is as follows: With a curved needle in a holder, threads of horsehair are passed through the gum from one side to the other (one usually being sufficient); the ends are then tied tightly, the effect being to exert pressure on the gum and at the same time retain the clot in position.

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[1] Bulloch and Fildes, "Treasury of Human Inheritance," Parts V and VI.

When the hæmorrhage proceeds from the socket the following mode of procedure is adopted: The socket is first freed from clot, then syringed, then dried out with a pledget of cotton-wool; a thin strip of antiseptic gauze is next firmly packed into the socket, care being taken that the gauze reaches the end of the socket; a plug of lint is then placed over all and kept in position by antagonism with the opposing teeth, a four-tailed bandage being used for this purpose.

If the approximal teeth are standing, an excellent method of keeping the plug in the socket is to wedge a piece of wood between them. But if the hæmorrhage is severe it is better to use the four-tailed bandage to make more certain of retaining the plug in position.

Calcium lactate should be employed, a dose of 60 grains being given, followed by three doses of 15 grains at intervals of four hours. In severe cases firm plugging of the socket is very important, and if the patient is unable to stand the pain a general anæsthetic should be administered.

The general directions to be given to the patient, though apparently trivial, are most important and should never be omitted. The patient should be advised to avoid all forms of excitement; to assume the sitting position usual during the day, and to use a high pillow at night. The patient should be fed through a bent tube and all fluids should be given cold.

When the blood coagulates readily, pressure is usually sufficient to arrest the bleeding, but if the blood does not coagulate it is advisable to assist the formation of fibrin by the local application of a preparation of fibrin ferment, an efficient form being "Protagulin."[1] To employ this drug the "protagulin" should be dissolved in normal saline solution, and applied to the base of the socket on a pledget of cotton-wool before inserting the plug of gauze.

Hæmoplastin is also advocated. It is a serum derivative from equine and bovine sources and consists chiefly of prothrombin, antithrombin and other thrombokinases in physiologically balanced solution.[2] It is supplied in bulbs containing 2 c.c., and in severe cases of hæmorrhage, in addition to the local application of the drug, 1 to 2 c.c. should be injected intravenously or subcutaneously, and the dose repeated every four to six hours until the hæmorrhage is controlled.

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[1] Protagulin can be obtained from Messrs. Bell and Croyden, 50, Wigmore Street, W.

[2] Hæmoplastin is prepared by Messrs. Parke, Davis and Co.

Oil of turpentine is strongly recommended by F. St. J. Steadman.[1]

In fifty cases which required packing of the sockets the bleeding ceased within two minutes. Oil of turpentine has the advantage of being a powerful antiseptic, so that when the gauze packing is removed it still has a faint smell of turpentine, and the wounds are much cleaner than in cases where other hæmostatics are used.

The patient should be seen within twenty-four hours after treatment. If the bleeding has ceased the plug may be removed and the wounds syringed regularly. With severe hæmorrhage the plug should be allowed to remain for two days, and if the hæmorrhage has not then ceased, the socket should be replugged. Should this prove of no avail and the bleeding be from the mandible, the canal should be trephined and a plug of ivory inserted to compress the artery against the inner plate of the bone. In uncontrollable hæmorrhage from the maxilla, digital pressure on the common carotid opposite the transverse process of the sixth cervical vertebra may be tried; should this fail to stop the hæmorrhage, ligature of that vessel must be resorted to. In one case of hæmorrhage from the region of the mandibular right third molar, Boyd divided the lip in the median line and reflected the cheek from the jaw. The mandibular canal was then laid open by excising the outer plate of the bone, and the bleeding was arrested by plugging the mesial and distal ends of the canal.

In extreme cases with signs of collapse normal saline solution must be infused into the median basilic vein. Cases of death from hæmorrhage following tooth extraction have been reported.

With patients predisposed to hæmorrhage extraction should be avoided if possible; but if the removal of the tooth be absolutely necessary, prophylactic treatment should be pursued for two days before the operation, by the administration of calcium lactate in doses of 15 gr. three times a day. The tooth should be extracted in the early morning, so as to have the whole day for treatment, should hæmorrhage occur. A dose of 60 gr. of calcium lactate should be administered at the time of the operation and the socket plugged at once as a preventive measure, for, be it remembered, it is far easier to prevent the hæmorrhage from occurring than to arrest it when once it has commenced. Should the bleeding prove to be uncontrollable, transfusion of blood from a normal individual must be carried out in order that the substance necessary to produce thrombin may be supplied.

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[1] *Brit. Dent. Journ.*, vol. xliii, p. 299.

(*g*) *Injury of the Arteries in the Neighbourhood of the Teeth.*—Wound of the lingual artery has been referred to under the heading of Injuries to the Tongue. Laceration of the ranine, anterior and posterior palatine arteries may also occur. Such accidents are usually the result of the forceps slipping and are therefore avoidable.

Treatment consists in pressure, or in twisting or tying the divided vessel. In the case of the anterior or posterior palatine artery it may be found necessary to plug the foramina which give passage to these vessels.

(*h*) *Pain following Tooth Extraction.*—The causes giving rise to pain following the extraction of a tooth are:—

(1) Incomplete extraction of the tooth, more especially when the remaining portion contains an exposed pulp.

(2) Too rapid healing of the orifice of the socket. It sometimes happens that the margins of the wound left after extraction unite very early, and when this occurs there is no exit for the discharges, which naturally come away from the granulating surface at the base of the socket, and the consequence is that they are retained and increase the inflammatory reaction in the surrounding tissues.

(3) Suppuration in the tooth socket.

(4) Extensive laceration of the hard and soft tissues in the neighbourhood of the socket.

(5) Septic osteitis is a common cause of pain following extraction and of persistent tenderness of the bone. In teeth which have been the seat of chronic periodontitis the surrounding bone is frequently infected, and although the infection is held in check by the local tissue defences, the barrier is broken down by the operation of extraction and the infection spreads. The severe earache and neuralgia which may follow extraction of the mandibular molars is due to infection of the nerve sheath and is a neuritis.

(6) Necrosis of the socket of the tooth.

(7) The presence in the wound of a foreign body. A curious example came under notice a few years ago. A patient applied for the extraction of the left first permanent molar. During the operation a portion of one of the cusps disappeared; a search proved fruitless, and it was supposed that it had been removed in rinsing the mouth. For the next three weeks the patient complained of slight pain in the socket, for which remedies were tried without success. Eventually the patient discovered the cusp on the top

of the granulation tissue which had filled up the socket. In another case of the same character which came under notice the offending material was a piece of an amalgam filling. A broken portion of a blade of forceps may be the offending body.

(8) Injury to the nerve. Direct injury to the trunk of the nerve is more likely to occur during extraction of the mandibular third molar than with any other tooth. It is probable that some obscure cases of pain following tooth extraction are due to exposure and irritation of the nerve at the apex of the socket. An interesting case of this character was reported by Storer Bennett. The patient. a lady aged 23, had had the maxillary third molar dislocated through the use of a Mason's gag, and as it was considered hopeless to restore the dislocated tooth it was extracted without difficulty. The socket, in spite of treatment, remained painful for the next twelve days, but in the meanwhile granulated healthily, except at its apex, where by the aid of a mirror and probe a spot about the size of a pin's head was noticed, which caused the greatest agony on being touched. Incision of the nerve produced permanent relief.

Where pain follows tooth extraction treatment must obviously depend in a great measure on the cause. A thorough examination of the socket should be made with probe and mirror. When due to incomplete extraction another attempt, if considered advisable, may be made to remove the tooth, and, if this is unsuccessful, the socket should be swabbed with an anodyne drug, and, if there is an exposed pulp in the remaining portion of the tooth, the pulp should be touched with strong carbolic acid. The patient should also be advised to use fomentations.

Where the orifice of the socket heals too rapidly, the freshly healed surfaces must be separated, the socket syringed out, and a small tent of lint allowed to remain in the orifice for about twelve hours. An antiseptic mouth-wash should also be prescribed.

In pain following extensive laceration and bruising of the soft tissues a mouth-wash containing chloride and sulphate of zinc is useful.[1] The pain of osteitis is difficult to allay, regular irrigation of the tooth sockets and the use of fomentations, together with the administration of aspirin in doses of 10 gr., is the most satisfactory method to adopt.

(*i*) *Traumatic Emphysema.*—A case in which traumatic emphy-

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Zinci sulphatis	gr. viii.
Zinci chloridi...	gr. vi.
Morphinæ acetatis	gr. ii.
Aquam	ad ℥viii.

M. Fiat lotio.

To be used with an equal quantity of water as a mouth-wash.

sema followed tooth extraction is recorded by A. Turnbull.[1] A bugler blew his bugle immediately after having had a maxillary premolar removed, and as a result his face became considerably swollen in consequence of the passage of air through the empty tooth socket into the cellular tissues.

(4) Difficulties, Complications and Sequelæ arising during Extraction under Anæsthetics

(*a*) *Tongue Slipping Back.*—During extraction under anæsthetics the tongue, not being under control, may slip over the larynx, or may be forcibly pushed back by the fingers of the operator. Symptoms of difficult breathing or even arrest of respiration will follow this accident. Treatment consists in pushing the mandible forward with the thumbs behind the angles or pulling the tongue forcibly forward with a suitable instrument.

(*b*) *Forcing out a Tooth with a Prop or a Mouth-opener.*—This accident may arise from resting a prop upon teeth which are loose, or from placing it in such a position that undue leverage is brought to bear on a tooth. It is an accident most likely to occur when the prop is fixed upon the front teeth and the mouth is opened to its widest extent. Under such conditions undue leverage at right angles to the long axis of the tooth is brought to bear upon the palatal surfaces of the maxillary teeth, and they are consequently forced outwards.

The accident may arise from clumsiness in the use of a mouth-opener, and great care should therefore be exercised when using this very powerful instrument. If a tooth is forced out it should, if possible, be immediately replaced.

(*c*) *Passage of a Foreign Body through the Isthmus of the Fauces.*—A foreign body, such as a tooth, a broken piece of forceps, or a prop, passing through the isthmus of the fauces may become impacted in either the air or food passages.

(i) In the air passages it may lodge (*a*) over the entrance of the larynx, (*b*) in the larynx, (*c*) in the trachea or bronchus.

(ii) In the food passages it may lodge (*a*) in the pharynx, (*b*) in the œsophagus, (*c*) at the pyloric opening of the stomach.

(i) *In the Air Passages.*—Should the foreign body lodge *over the entrance of or in the larynx*, the patient will be seized with a violent fit of coughing which may expel it, but if it is not expelled symptoms of asphyxia will supervene. Treatment: the head should immediately be brought forward and the finger inserted along the side of the mouth into the pharynx, and then given a forward sweeping movement; by this means the foreign body, if lodged at the back of the tongue, will probably be removed. If the foreign body is not dislodged by this method, laryngotomy should immediately be undertaken and carried out promptly, as any delay diminishes the chance of saving the patient's life.

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[1] *Brit. Med. Journ.*, May 5, 1900, p. 1131.

A foreign body in the trachea or bronchus usually gives rise to a violent fit of coughing with signs of impending asphyxia. These signs pass away and are followed at intervals by fresh attacks of coughing and eventually by symptoms of collapse of the lung or lungs.

When there is a suspicion that a tooth or a piece of a broken instrument may have passed into a bronchus, prompt measures must be taken. In the first place an examination must be made with X-rays, and this, even if negative in character, should be followed by a thorough examination of the chest by auscultation and percussion. In the event of the foreign body being lodged in a bronchus, immediate steps should be taken to remove it. This was formerly an extremely difficult undertaking, but the introduction of the bronchoscope has greatly facilitated the removal of such foreign bodies.

(ii) *In the Food Passages.—A foreign body impacted in the pharynx* will give rise to pain, symptoms of dysphagia and dyspnœa. The patient generally has a hacking cough. Should a foreign body be suspected in the pharynx, its presence can usually be ascertained by digital exploration; this failing, the cavity should be examined by the aid of a laryngoscope.

An attempt should first be made to remove the body with the fingers; and if this is unsuccessful pharyngeal forceps must be called into use. Where the impaction is very firm, it may be necessary to perform pharyngotomy.

A foreign body in the œsophagus will cause dysphagia, and will probably give rise to constant pain; if it is situated in the upper part it will in all probability give rise to dyspnœa. On applying the stethoscope over the region of the œsophagus, a gurgling sound will be heard when the patient swallows fluids. The presence of a foreign body may be definitely ascertained by the use of the X-rays. If impacted in the upper part of the œsophagus an attempt may be made to remove the impacted body with forceps; this failing, œsophagotomy must be performed. If lodged near the cardiac end of the œsophagus an attempt may be made with a bougie to push the foreign body into the stomach; this failing, gastrotomy should be performed.

If a foreign body becomes impacted at the pyloric opening of the stomach, it will give rise to gastric dilatation. In such circumstances the stomach must be emptied of its contents, and gastrotomy then performed.

(5) Miscellaneous Difficulties, Complications and Sequelæ

(*a*) *Menorrhagia.*—A case is recorded in which a married woman, aged 25, unipara, was seized with violent bleeding from the uterus after the removal of teeth under chloroform anæsthesia. Packing the uterus with tampons saturated with various solutions, and the administration of ergot and strychnine, were tried without success. Finally the uterus was curetted and packed, the hæmorrhage ceasing at the end of twenty-four hours. An examination of the scrapings from the uterus showed the presence of chronic follicular endometritis. Menorrhagia is liable to occur with such local conditions as endometritis, and it is possible that the extraction of the teeth, combined with the chloroform anæsthesia, may have been indirectly responsible for the menorrhagia. The lesson to be learnt from this case is the necessity of avoiding dental operations as far as possible during the menstrual period.

(*b*) *Shock.*—The fact that tooth extraction is a surgical operation and may be followed by shock is often overlooked. As a rule, the shock which follows tooth extraction is negligible, but at times it may be well marked, especially in the weak. The effects of shock are often not sufficiently taken into account when a question arises as to the number of teeth to be extracted at one sitting. It should clearly be borne in mind that a strong, able-bodied person can bear more severe operations than one of weaker physique.

(*c*) *Syncope at the time of the operation sometimes occurs.* In these circumstances, the operator should immediately desist until recovery ensues. Fainting is best treated by bending the head down towards the knees, at the same time loosening anything tight about the neck and waist and applying ordinary salts of ammonia to the nose. In severe cases the patient should be removed from the chair and laid on the floor, and the chest should be exposed and flipped with a towel dipped in cold water. In more severe cases it may be necessary to inject a cardiac stimulant. Fatal syncope following tooth extraction has occurred. In one case recorded[1] the patient was a female, and an attempt was made to remove a tooth, but owing to alarming syncope the operation was abandoned. A second attempt was about to be made when fatal syncope ensued.

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[1] *Journ. Brit. Dent. Assoc.*, vol. vii, p. 32.

Post-mortem examination showed nothing beyond a slight amount of cerebral congestion.[1]

(*d*) *Epilepsy.*—When a person is predisposed to epilepsy an attack often commences immediately after the extraction of a tooth. If a fit occurs, the patient should be removed from the chair and placed on the floor, the clothes at the same time being loosened and a wedge of wood or some suitable material placed between the teeth to prevent injury to the tongue.

(*e*) *Inhibition of the Salivary Glands.*—A case has been recorded by G. L. Curnock[2] of inhibition of the salivary glands following the removal of a difficult mandibular molar. Within twenty-four hours there was great pain, the socket of the tooth was extremely septic, and the flow of the saliva had apparently ceased. The cause appears to have been psychical, as the operation had been dreaded, and a somewhat similar condition had followed on the occasion of an air raid.

(*f*) *Septic and Infective Sequelæ.*—In the description of acute local periodontitis (p. 464) attention was drawn to the spread of the infection from the teeth to the cellular tissues of the face and neck. Mention was also made of the infection of the bone which is often present in periodontal disease, an infection which must be regarded as latent. The removal of these chronically infected teeth is sometimes followed by the development of an acute general infection. The surrounding soft tissues swell rapidly, the wounds become extremely septic, and symptoms of general infection appear.

Four cases of this character are recorded by W. G. Spencer,[3] and he attributes the condition to an acute infection of the raw surfaces of the gums and bare alveoli from sepsis around the mandibular incisors. It seems, however, more likely that the latent infection in the bone is started into activity by the operation.

Thrombosis is a rare sequela, and would seem to be more likely to occur in cases where it has been necessary to arrest bleeding by plugging. An instructive case was recorded by S. P. Mummery.[4] A man, aged 72, had fifteen teeth removed at one sitting under nitrous oxide and oxygen, the bleeding ceasing soon after the operation. The teeth were firm and the alveolar process thickened. The same evening there was an outbreak of hæmorrhage, which was arrested without difficulty; the following day there was a slight general oozing from the sockets, and the next day a fresh outbreak of bleeding which was arrested by plugging. On the fourth day the bleeding broke out again and fresh plugs of adrenalin gauze were inserted. The temperature and pulse remained normal and the mouth clean. On the eighth day the temperature suddenly rose to 104° F., signs of thrombosis of the vessels of the arm appeared, and death occurred within the next twenty-four hours. *Post-mortem* examination revealed a small carcinoma in the prostate, some secondary deposits, and considerable thrombosis in many of the large veins.[1]

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[1] See also case recorded in *Journ. Brit. Dent. Assoc.*, vol. xvii, p. 385.

[2] *Brit. Dent. Journ.*, February 1, 1918, p. 75.

[3] *Ibid.*, January 28, 1922, p. 132.

[4] *Proc. Roy. Soc. Med.*, vol. vii (Odonto. Sec.), p. 84.

Where septic and infective conditions follow the extraction of teeth it would be unfair to attribute the infection to the actual operation as a matter of course; as in many cases the infection is unquestionably caused by the neglected condition of the extracted teeth. Infection can, however, at times be directly traced to the operation, and once again attention is drawn to the urgent necessity of adopting aseptic precautions. Cases of syphilis acquired through the use of infected forceps are recorded.

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[1] See also case recorded by J. W. Tomlinson, *Dental Record*, vol. xl, p. 314.

CHAPTER XXVIII

Replantation, Transplantation, and Implantation of the Teeth

Replantation is the operation of replacing in its socket a tooth which has been partially or completely dislocated.

Transplantation is the operation of transferring a tooth from its own socket to that of another tooth. The transfer may be made in the same mouth, or from one mouth to another.

Implantation is the operation of forming an artificial socket in the bone for the introduction of a natural tooth.

Of these three operations, the only one which is performed to any extent in this country is replantation, the other two being of questionable utility.

(A) REPLANTATION

Replantation should be performed only in cases of traumatic dislocation.

The operation consists in gently rinsing the tooth in a solution of some antiseptic, and replacing it in the socket with firm pressure, the alveolar process being moulded around it with the fingers. The tooth may be kept in place by a metal splint similar to that recommended on p. 193. If the patient is not seen for some hours after the accident, the pulp must be removed, and the canal filled before the tooth is replaced.

The union after replantation is brought about through the periodontal membrane. If the tooth is living and is replaced immediately, the vitality of the pulp is sometimes re-established. Magitot, who has recorded a large number of cases of replantation, maintains that the operation cannot be successful unless there is a complete ring of healthy membrane on the tooth.

The results of replantation depend upon the nature of the condition for which the operation is undertaken. If the tooth is replaced immediately after dislocation a successful result may be anticipated; but if replacement is delayed the prognosis is naturally not so good.

(B) TRANSPLANTATION

There are three distinct objections to the operation of transferring a tooth from one mouth to another: (1) The risk of failure; (2) the risk of inoculation; (3) the moral objection. Failure of the operation may be due to (*a*) want of adaptability of the tooth to its new socket; (*b*) morbid conditions of the new socket. The risk of inoculation is a strong argument against this operation—a case of transmitted syphilis has been recorded within recent times. The moral objection to the operation is also weighty, as the teeth to be transplanted are usually obtained from the poorer classes. All circumstances considered, transplantation of a tooth from one patient to another is to be condemned. The method recommended for carrying out the operation is as follows: The patient to receive the transplanted tooth is first operated upon, as little injury as possible being inflicted, and the bleeding from the socket arrested as far as possible. The tooth to be transplanted is next removed from the other patient and immediately transferred to the vacant socket and forced well into place. The transplantation of a tooth from one socket to another in the same mouth is occasionally useful, as, for example, the transfer of a healthy second incisor which has erupted internal to the arch to the socket of an unsavable first incisor.

Union in transplantation may be a process similar to that which takes place in replantation; or the process may be similar to that which occurs in implantation, viz., absorption in the first place of portions of the root and the subsequent formation, in the excavation, of bony tissue continuous with the alveolar process, the tooth thus becoming anchylosed to the jaw. In other cases, it seems possible that there is only a fibrous union.

(C) IMPLANTATION

Implantation is an operation of more recent date than either replantation or transplantation, and is probably less justifiable even than transplantation. W. J. Younger, who introduced implantation, is very circumspect in choosing patients for this operation, and never performs the operation unless the patient is young and healthy. The tooth to be implanted must possess a healthy periodontal membrane.

The method of procedure is as follows: A crucial incision is made over the situation intended for the implanted tooth; the flaps of periosteum are then dissected up, and, by means of specially designed trephines and burs, a fresh socket is made. The socket is then syringed so as to remove all debris, and the bleeding is then arrested, the tooth being fixed into place and, if necessary, secured with ligatures or other suitable means. Some operators force the tooth into place with a hammer; in this way the tooth is firmly fixed and ligatures are not required. Younger does not always use freshly extracted teeth to perform implantation, but in some cases employs dry teeth.

The union after implantation probably takes place in a manner similar to that following many cases of transplantation. A. Amoedo advocates slight decalcification of the roots before implantation. The root is placed in a 10 per cent. solution of hydrochloric acid for from three to four hours until the surface of the cement is slightly softened, the acid being afterwards neutralized with ammonia. The results obtained from implantation are not encouraging, and do not justify the operation.

CHAPTER XXIX

Fractures of the Jaws

This subject may conveniently be considered under two heads:—
(A) Fractures of the jaws (civil life injuries).
(B) Gunshot injuries of the jaws.

(A) Fractures of the Jaws (Civil Life Injuries)

(1) FRACTURES OF THE MANDIBLE

Fractures of the mandible are more common than fractures of the maxilla, and this is no doubt due to the fact that the mandible is in the more exposed position. The fractures occur more often in the body of the bone than in the ramus; in the body of the bone they are usually compound, in the ramus they are usually simple. The bone is generally fractured in one place only, but multiple fractures are not uncommon.

In a few cases of fracture a portion of a tooth is situated in either fragment.

(α) *Causes.*—Fractures mostly result from kicks, a blow of the fist, or a fall (especially on the chin). Undue violence in the extraction of a tooth may fracture the body of the jaw, but rarely causes a direct transverse fracture (see p. 758). Fracture of the alveolar process during extraction is a common occurrence, but as it leads to nothing more serious than the exfoliation of the portion fractured, the injury is of little importance. Some rare causes of fracture, as, for example, a fit of coughing, are recorded in "Gross's Surgery," p. 964.

(β) *Position.*—The position of the fracture depends on the locality in which the blow is received. The most common position of fracture is in the neighbourhood of the canine, and a fracture thus situated is invariably caused by force applied to the chin. When a fracture is caused by a blow on the front of the chin a little to one side of the mid-line, it is usually situated in the **region of the canine** on the opposite side, the explanation generally accepted being that the depth of the canine socket weakens the bone in this region. Another explanation of the frequency of fracture in this region and one which seems more satisfactory is as follows: The resistance to a blow on the side of the chin is met at the articulation of the opposite side; the segment of bone between the regions of impact and the resisting area is a curve; the force of the blow increases the convexity of the curve and the bone gives way at the point of greatest convexity, which is usually between the canine and first premolar. If a blow is received under the middle of the chin the resistance is met at both condyles and the **neck of the condyle** is fractured on one or both sides; in a few cases the neck of the condyle is driven into the condyle causing an impacted fracture. In the case of young children a fall on the chin may lead to a transverse fracture at the **symphysis.** Fracture in the neighbourhood of the **angle** is usually due to direct violence. Fractures of the **ramus** are generally the result of great violence and may occur in almost any position.

(γ) *Symptoms.*—With fractures in the body of the bone the symptoms are generally well marked, but with fractures of the ramus the symptoms are often obscure. In either case the patient usually complains of **pain** on opening the mouth. In the former there will be distinct crepitus, **mobility in the continuity of the part,** and, frequently, alteration in the line of the teeth, due to **displacement.** The pain in cases of fracture is generally referred to the injured area, but in fractures about the angle the pain is at times referred to the mental foramen. In fractures of the portion of the mandible lying between the inferior dental foramen and the mental foramen, cutaneous anæsthesia is usually present over the area supplied by the mental nerve. There is often more or less salivation and, when the displacement is great, there is sometimes inability to close the mouth.

Radiograms should be obtained in all cases of suspected fracture. It is advisable to obtain both antero-posterior and lateral views, as the **interpretation of radiograms** of the jaws is rendered difficult by the shadows on the plate of the skull and the vertebræ, and errors can easily be made. For example:—

(i) If the fragments slightly overlap, the line of fracture will be masked in the lateral view; the antero-posterior view will, however, show the line quite clearly.

(ii) Lateral views of the ramus are often obscured by shadows of the vertebræ and the shadow of the intervertebral discs may simulate a line of fracture.

(iii) In antero-posterior views of the incisor region the shadow of the intervertebral disc may be mistaken for a horizontal fracture.

(δ) *Displacement.*—The displacement will vary according to the character and position of the fracture, and will be slight in some cases and well-marked in others.

When a fracture occurs in the **incisor region,** the position and direction of the fracture will govern the displacement.

As a rule no displacement occurs with vertical fractures in the region of the first incisors because the depressors and elevators of the mandible counterbalance one another. The " slewing " action of the external pterygoids obviously cannot operate with vertical fractures. But the farther the line of fracture is removed from the median line of the mandible the greater will be the tendency to displacement. The digastrics, with the genio-hyoids, are attached to the inner aspect of the bone on either side of the median line; consequently, the depression of the larger fragments by these muscles tends to increase as the seat of fracture is removed farther from the median line.

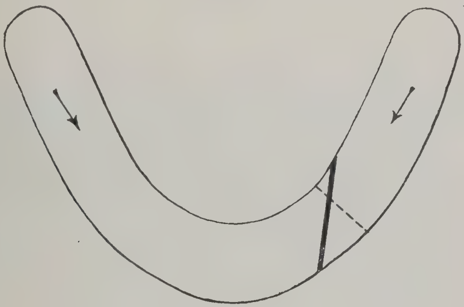

FIG. 857.

The arrows indicate the direction of force exerted by the external pterygoids.

When the fracture runs obliquely through the bone, the action of the external pterygoids will cause the fragments to overlap. Thus, in the left **canine region,** if the fracture runs through the bone from within outwards and forwards, the tendency will be for the left external pterygoid to force the smaller fragment towards the right, and for the right external pterygoid to force the greater fragment to the left, and the combined action will cause the fragments to slide one over the other, the lesser moving in front of the greater. The action of the external pterygoids is diagrammatically shown in fig. 857. The muscles which close the jaw will have a tendency to draw up the lesser fragment because there is no opposition from any of the depressors of the jaw; the depressors are all attached to the greater fragment and depress it, the right and left depressors combined exerting more force than the counteracting right elevators.

In double fractures through the canine region, with the lines of fracture taking oblique directions, the following displacement may occur: Attached to the central fragment are the digastrics, the genio-hyoids and the genio-hyoglossi, and the action of these muscles is to depress the fragment and cause it to fall over towards the tongue; the elevators of the mandible are attached to the lateral fragments and draw them slightly upwards; the left external pterygoid tends to draw the left fragment to the right and the right external pterygoid tends to draw the right fragment to the left, the result being that the lateral fragments move towards the median line and the inward displacement of the central fragment is increased (see fig. 858). In reducing fractures of this kind the foregoing facts should be kept clearly in mind.

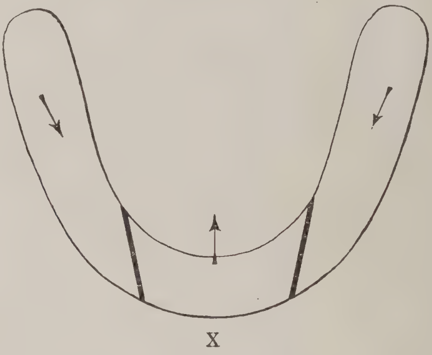

Fig. 858.—(X) Central fragment to which the depressors of the mandible are attached. The arrows indicate the direction of force exerted by the external pterygoids.

With fractures in the **molar region,** the anterior fragment is drawn downwards by the depressors of the mandible. The displacement of the posterior fragment is governed by the resistance to the upward pull of the elevators of the mandible. This resistance depends upon (i) the presence or absence of teeth and (ii) the direction of the line of fracture. If teeth are present in the posterior fragment as well as in the maxilla, the upward pull is resisted irrespective of the direction of the line of fracture. If the fragment is without teeth or possesses only teeth which are unopposed by maxillary teeth, a displacement upwards and forwards will occur, provided that the line of fracture does not resist the movement. To make this statement clear, attention is drawn to the diagram (fig. 859). If the break takes the form (*a*), (*b*), or (*c*), the upward and forward pull is resisted by the anterior fragment, but when the break is as shown in (*d*), there is no resistance to the upward and forward movement and considerable displacement follows (see fig. 860).

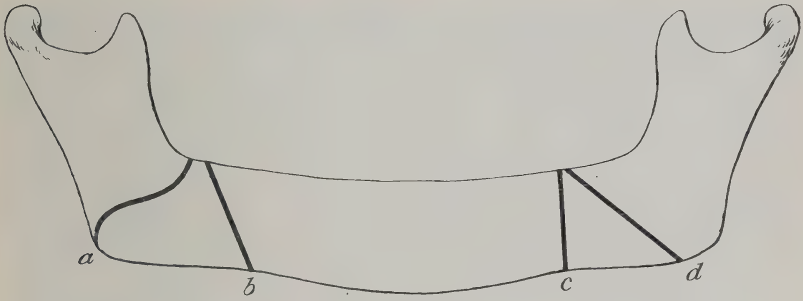

FIG. 859.

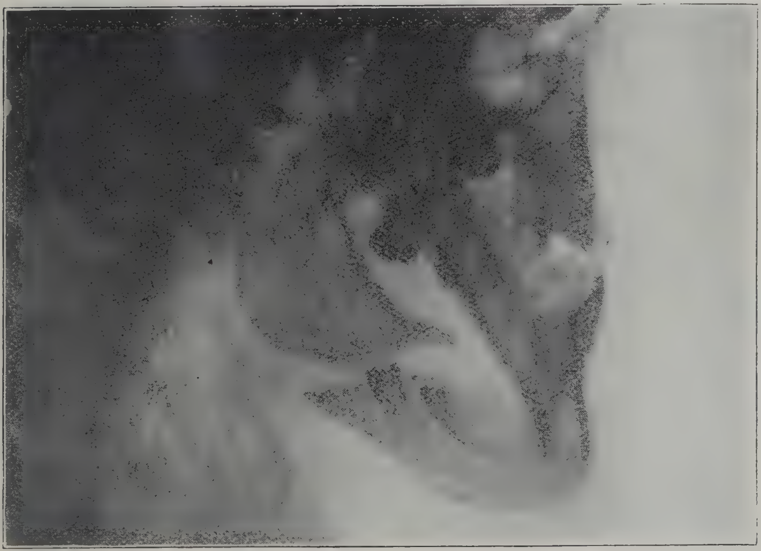

FIG. 860.—Fracture through the region of the second molar, showing marked upward displacement of the posterior fragment.

An instructive case is shown in figs. 861 to 863. The jaw was struck in the locality of the left molar teeth. The bone was fractured on the left side about the region of the third molar and on the right side in the position of the premolars. In both fractures the break of continuity took the form of a curve, as shown in the diagram (fig. 861). Both the posterior fragments, which were without teeth, swung forwards and slightly upwards, following the direction of the curves, the combined forward movement pushing the central fragment well forwards so that the patient presented a

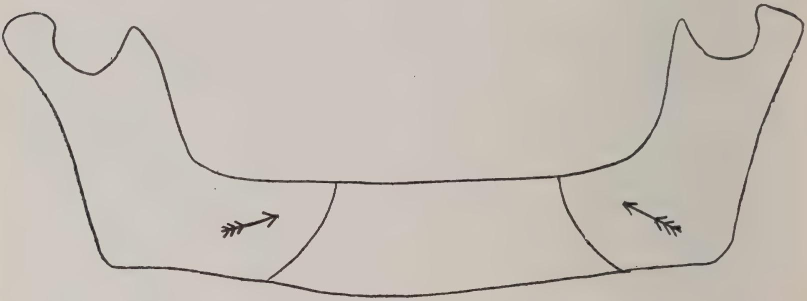

FIG. 861.[1]—The arrows indicate the direction of force exerted by the muscles attached to the posterior fragment.

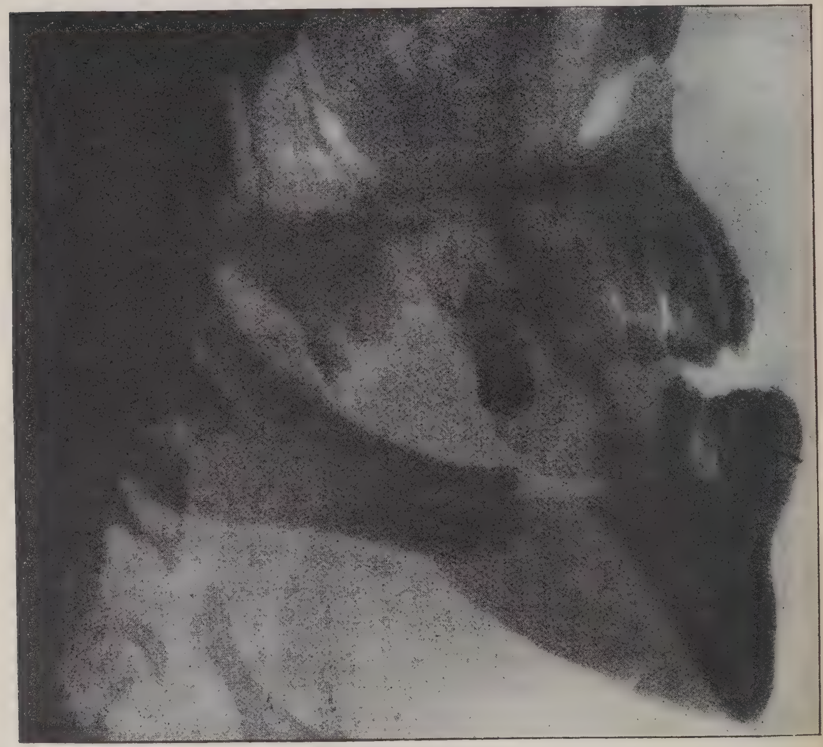

FIG. 862.[1]

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[1] From *British Dental Journal.*

condition of inferior protrusion. The radiograms of this case are shown in figs. 862 and 863.

Fractures in the molar region are often due to **direct** violence, the force of the blow driving one of the fragments inwards. In such cases the forward movement of the posterior fragment and the deviation of the anterior fragment to the injured side result in an overlap of the fragments which is at times extremely difficult

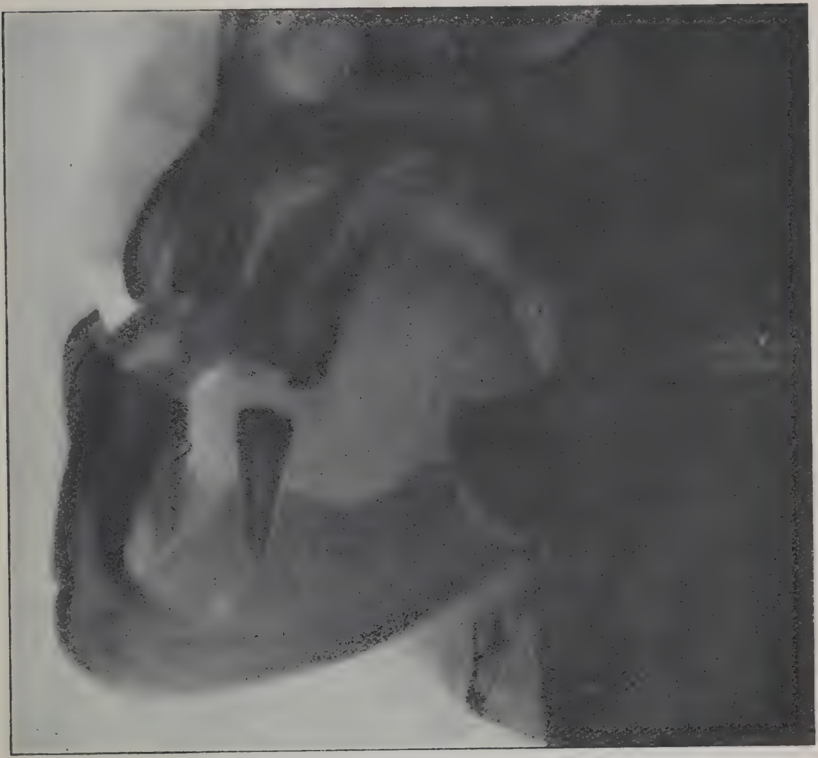

Fig. 863.[1]

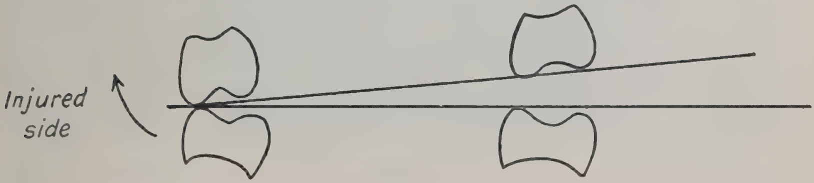

Fig. 864.[1]

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[1] From *British Dental Journal.*

to control in consequence of the action of the superior constrictor of the pharynx. This muscle has an attachment to the mandible immediately above the posterior extremity of the mylohyoid ridge, and each act of swallowing exerts an upward and inward drag on

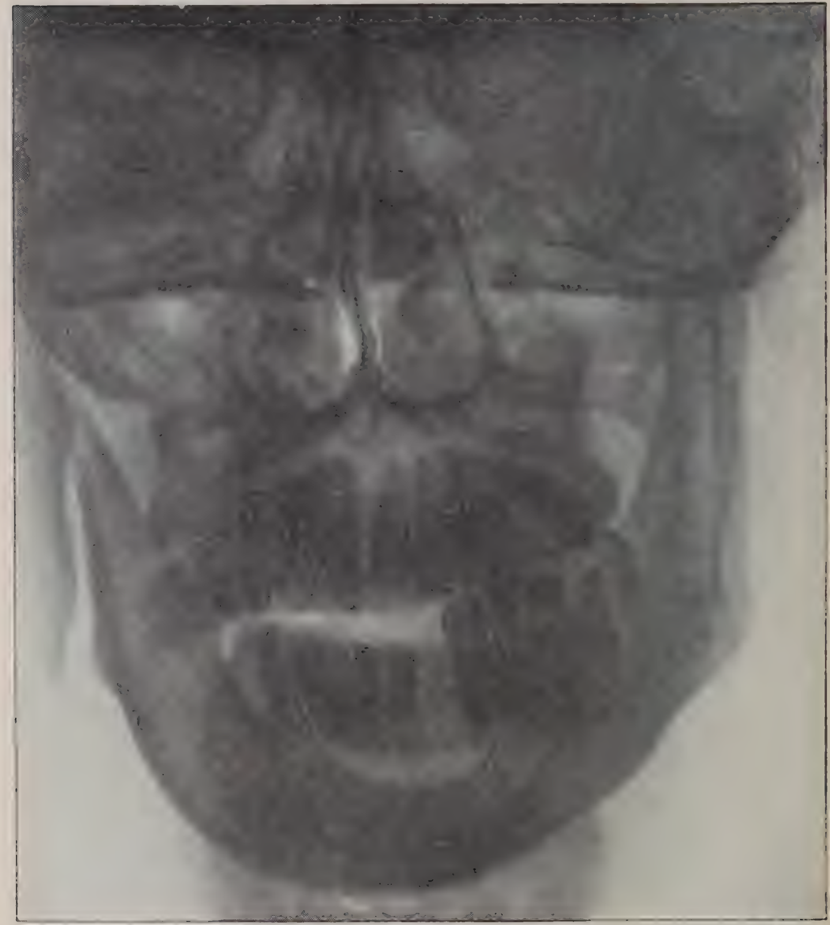

Fig. 865.[1]

the posterior fragment. When the posterior fragment lies internal to the anterior, the " drag " can be observed if the patient is made to close the mouth and swallow. When the posterior fragment lies external to the anterior, the inward and upward movement is prevented by contact with the anterior fragment, in other words, the movement of the fragment is controlled.

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[1] From *British Dental Journal.*

Fractures of the ramus are generally accompanied by much swelling, but usually the displacement is slight. With transverse fractures, the upper fragment, to which the temporal muscle is attached, moves a little forward, while the lower fragment moves a little backwards and inwards.

In *fractures of the neck of the condyle* the mandible is drawn upwards on the injured side and also over to that side, the condyle being drawn forward on the eminentia articularis by the external pterygoid muscle. The distal molar teeth on the injured side are in contact, the remaining teeth being separated. This malocclusion is brought about as follows: The upward pull of the muscles on the injured side brings the external aspect of the outer cusps of the mandibular teeth hard against the inner aspect of the outer cusps of the maxillary teeth; a continuation of the upward movement tends to rotate the jaw around these points of contact, as shown in the diagram (fig. 864).

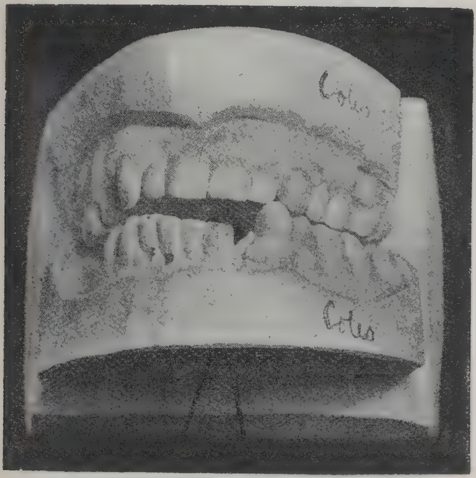

Fig. 866.[1]

When both condyles are fractured, the mouth is "gagged" open on the posterior teeth, producing a condition of "open bite."

When the *coronoid process* is fractured, there is no displacement with the teeth in occlusion, but, on opening the mouth, the mandible may deviate away from the injured side owing to the unopposed action of the temporal muscle on the uninjured side.

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[1] From *British Dental Journal.*

A severe blow on the chin may fracture the mandible in the incisor region on the one side and through the ramus on the other side. A typical instance is shown in figs. 865 and 866. On the left side the bone was fractured in the position of the canine in an oblique direction, and on the right side the ramus was split in a vertical direction. The displacement in this type of injury is as follows: The left fragment passes to the right; the central fragment is rotated so that the anterior end is displaced downwards and the posterior end upwards. The depressors of the jaw being attached to the anterior end of the fragment, and the elevators being attached to the posterior end, the pull of each set of muscles is in opposed directions, and the fragment is rotated at the area of contact between the last molars.

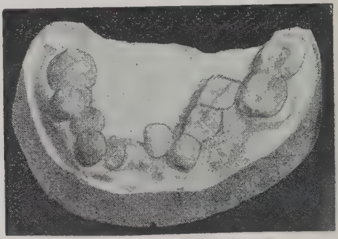

FIG. 867.[1]

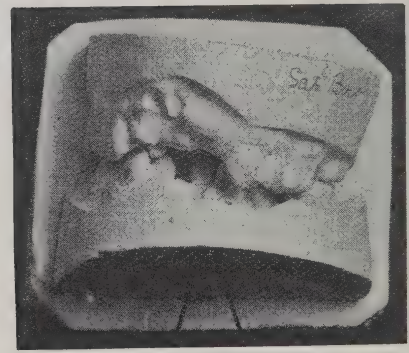

FIG. 868.[1]

With severe injuries, such as those caused by a kick from a horse, the jaw is often fractured in several directions, the force and direction of the blow being a potent factor in determining the degree of displacement. As an example the case shown in figs. 867 and 868 may be quoted. The injury was due to a mule kick in the region of the first molar on the left side.

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[1] From *British Dental Journal.*

The bone injuries were: (i) A fracture near the mid-line running downwards and backwards to the lower border of the bone; (ii) a vertical fracture between the first and second molars; (iii) a horizontal fracture connecting the two vertical fractures (see fig. 869). There was practically no comminution of the bone. In this case the left lateral fragment had swung forwards and upwards, and, owing to the backward displacement of the central fragment the first molar was lying on the inner side of the second molar. The right lateral fragment had swung over to the left and was slightly depressed.

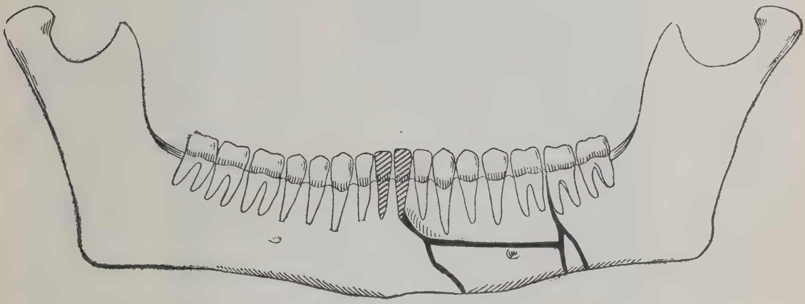

Fig. 869.[1]

(ε) *Complications.*—The principal immediate complications in fractures of the mandible are extensive bruising of the soft tissues with, in a few cases, considerable laceration. Hæmorrhage is in some cases troublesome and seems to occur most frequently in fractures about the angles. It is probably due to the artery being torn and not completely divided. In rare instances a traumatic aneurism forms, and necessitates the ligature of the external carotid. The fracture may be associated with a dislocation of the temporo-mandibular articulation and occasionally with a fracture of the base of the skull.

(ζ) *The Healing of Fractures of the Mandible.*—Repair of the fractured mandible takes place in a manner similar to repair of long bones. Briefly, the stages are as follows:—

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[1] From *British Dental Journal.*

(i) The fractured ends are surrounded with a coagulated mass of leucocytes, blood and exudation from the vessels in the neighbourhood.

(ii) The coagulum is invaded by cells—polynuclear from the surrounding soft tissues, fibroblastic from the periosteum and medulla.

(iii) The coagulum is in time replaced by tissue derived from the periosteum and medulla. This tissue is

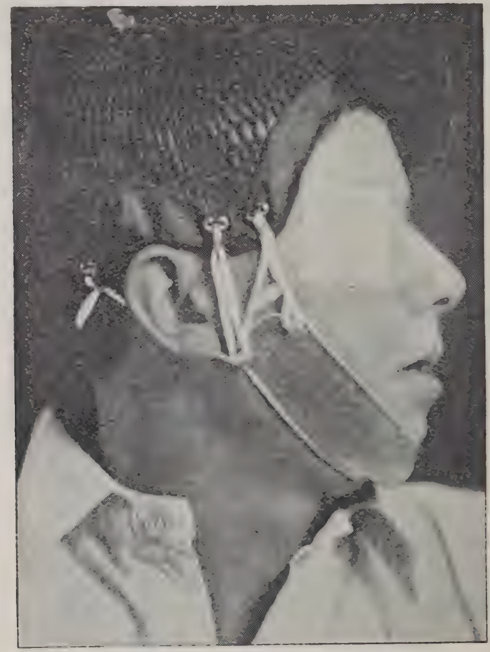

Fig. 870.[1]

(iv) Converted into cartilage. (In cases where the callus is small this stage may be lacking.)

(v) The cartilaginous tissue is converted into osteoid callus, i.e., the cartilage cells are modified into bone corpuscles with a deposit of calcareous salts in the matrix leading to the formation of imperfect bone.

(vi) The imperfect bone is in time replaced by lamellar bone. This last stage is seen in fig. 897.

In *simple fractures osseous union is usually complete in six*

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[1] From *Brit. Dent. Journ.*

weeks, but in cases where the treatment has been delayed, or there has been difficulty in reducing the fragments, union may not be complete in less than eight or ten weeks. In cases of doubt a radiogram should be obtained.

(η) *Treatment.*—The treatment of fractures of the mandible consists in (i) control of the sepsis; (ii) reduction of the displacements; (iii) immobilization of the fragments.

As soon as the patient comes under treatment the mouth should be frequently irrigated with peroxide of hydrogen (2 vols.), and the gums swabbed once a day with a 2 per cent. solution of iodine in alcohol, and the fracture rested with a *skull and mandibular splint* (fig. 870). This apparatus consists of a skull cap woven out of thick mercerized cotton and bordered by a rim of braid about three-quarters of an inch wide. Hooks are fitted on each side, two being placed in front and one behind. The mandibular splint is made of metal, the ends of the splint being turned over to form catches. The skull and mandibular sections are united by cord or tape and, according to the pressure exerted, either an upward or a backward pull can be obtained.

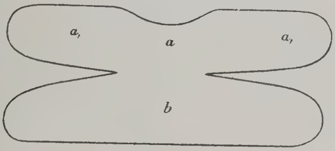

FIG. 871.[1]

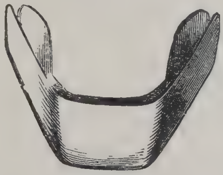

FIG. 872.

If a skull and mandible splint is unobtainable, a temporary rest splint of gutta-percha can be substituted. A piece of gutta-percha is cut similar in shape to that shown in fig. 871, and is softened in hot water; the part (a) is placed under the chin, the two ends (a_1) being bent upwards over the rami; the portion (b) is then bent round as shown in fig. 872. Several holes should be made to allow of evaporation; the splint should be lined with cotton-wool and held in position with a four-tailed bandage.

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[1] From *British Dental Journal.*

Radiograms should be obtained, and as soon as his condition permits the patient should be given an anæsthetic, in order that the teeth bordering on the line of fracture or communicating with the fracture may be removed as well as any septic teeth which may be present. If the extractions are likely to be difficult, anæsthesia should be induced by the administration of chloroform or ether. Before the operation is commenced the tongue should be brought under control by suitable means, and, during the operation, care should be taken to control the hæmorrhage.

The removal of the teeth in the region of the fracture is considered by some practitioners to be an unnecessary step, but in my opinion it is essential treatment. When the line of fracture passes through the socket of a tooth the periosteum of the root is detached and a pocket is formed which becomes filled with septic matter. The periosteum covering that part of the root is destroyed, and a permanent " pocket " is formed from which infection is constantly passing to the fractured area. The removal of the tooth or teeth eradicates this focus of infection and rapid healing follows. A perusal of the records of the cases quoted in the following pages will convey an idea of the results obtained by free extraction of the teeth in the region of fracture. But the best evidence in favour of this method of treatment is to be found in a study of cases of delayed union. The radiograms of many of these cases show the roots of teeth in the line of fracture, and the removal of the teeth is invariably followed by rapid healing of the fracture.

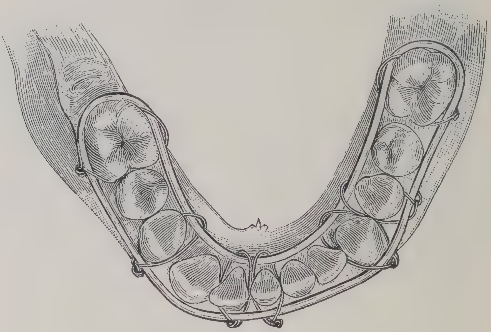

Fig. 873.

The *immobilization of the fragments* is usually carried out by means of interdental splints or wiring.

(i) *The Interdental Wire Splint.*—This splint, which bears the name of Hammond, is made of wire encircling the lingual and labial sides of the teeth, the individual teeth being wired to the splint (fig. 873). The splint is difficult to adjust, and the wire

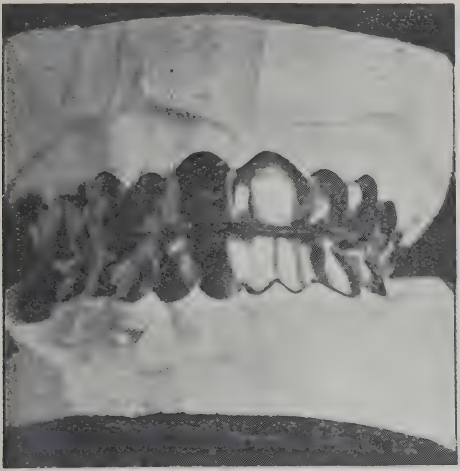

Fig. 874.

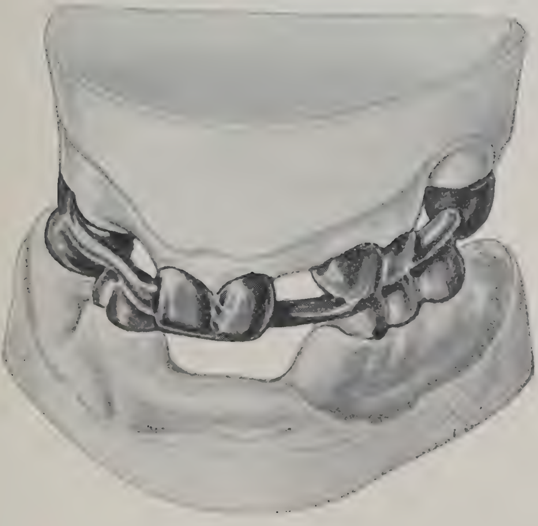

Fig. 875.

ligatures hurt the gum margin. It cannot easily be kept clean and cannot be relied upon to immobilize the fracture.

(ii) *The Metal Cap Splint.*—This splint consists of a metal cap fitted accurately to the teeth and is fixed into position by means of oxyphosphate of copper cement. A double metal cap-splint embracing both maxillary and mandibular teeth is the most reliable of all the types of splints (see figs. 874 and 875).

For the construction and adaptation of this type of splint the procedure is as follows:—

(*a*) Accurate impressions of the teeth are obtained in "Stent" composition.

(*b*) The caps are made of Victoria metal and are cast. In casting the metal a plentiful supply of flux is employed and care is taken not to overheat the metal.

(*c*) The splint is made in sections; for example, in a case where the teeth have been removed from the line of fracture, separate caps are made for the teeth in the two fragments.

(*d*) The model of the splint is made in wax (No. 8 thickness), the wax being carefully pressed between the teeth and extended as far as the gum margin.

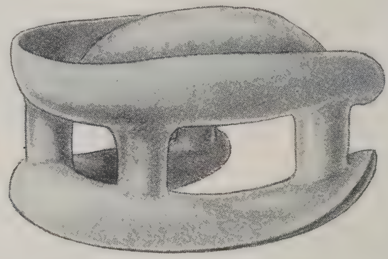

Fig. 876.

(*e*) The caps are adjusted to the teeth, care being taken to see that the occlusion is correct. The fracture is reduced, and the position of the caps fixed with composition.

(*f*) The sections of the splints are soldered together with silver solder, connecting bands of wire being used if necessary.

(*g*) The splint is finally adjusted in the mouth, the fracture reduced, and the splint fixed with oxyphosphate of copper cement.

In cases where the displacement is marked, reduction must be carried out by easy stages.

(iii) *The Gunning splint* (fig. 876) consists of vulcanite caps joined by supports, and constructed to fit both the maxillary and the mandibular teeth or gums. When the splint is in position a skull and mandibular splint or a four-tailed bandage is applied. With this type of splint the fractured jaw is fixed between the mandibular splint outside and the cranium. The Gunning splint is useful in cases where the patient is edentulous or possesses few teeth.

In many cases a combination of metal caps and vulcanite is found very useful. There are many other types of splint, but the experience gained from the treatment of war injuries has shown that the best results are obtained with either the metal cap splint or the Gunning splint.

The Gradual Reduction of Displacements.—The gradual reduction of a fracture may be carried out in a variety of ways, different operators preferring different methods. The method adopted in the following cases gives excellent results:—

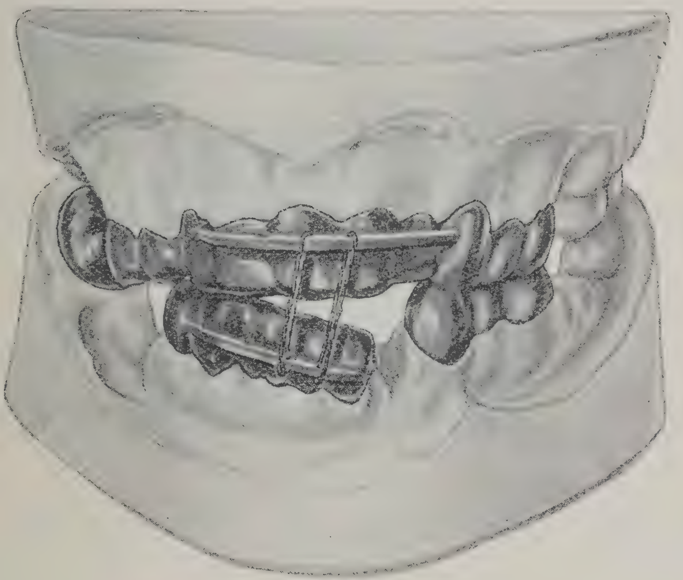

FIG. 877.

In the case shown in fig. 877 a double metal cap splint was fixed to the maxillary teeth and the teeth on the left side of the mandible, a single cap splint being fixed to the teeth on the right side of the mandible with studs soldered to the mesial end. On the double cap splint studs were fixed immediately above the position of the studs on the lower splint. Upward traction was exerted on the displaced fragment and a ligature of wire bound round the studs (fig. 877). Additional traction was exerted each day until the displacement was overcome. In this case the fragment was rotated into position, the rotation taking place at the contact between the last molar teeth.

In a few cases it is advisable to reduce the fracture before removing the teeth. This method was adopted in the case shown in figs. 878 and 879.

The model of the mouth was obtained with extreme difficulty. The teeth present were:—

$$\begin{array}{r|l} 876\ 43\overset{*}{2}\overset{*}{1} & \overset{*}{1}\ 34\ 6\overset{*}{7}8 \\ \hline 8765432 & \quad 2345678 \end{array}$$

The case was treated as follows: A splint was constructed which firmly capped the premolars and molars on the right side and the second and third molars on the left side; the two caps were joined with a screw extension (fig. 878), the force being exerted to push the left fragments outwards and allow the central fragment to move forwards. The apparatus was adjusted, and six days later the displacement had been so much reduced that the second molar only just overlapped the first molar. The following teeth were then removed—

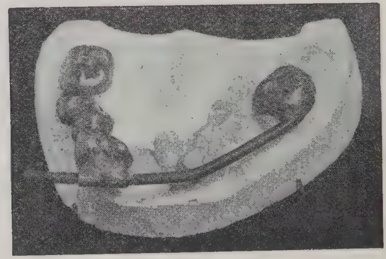

FIG. 878.[1]

$$\begin{array}{r|l} 7 \qquad \overset{*}{2}\overset{*}{1} & \overset{*}{1} \qquad \overset{*}{7} \\ \hline 2 & 2 \quad 67 \end{array}$$

and three days later a metal Gunning splint was fixed in position. At the end of three months there was firm osseous union with the teeth in good position (fig. 879).

In this case complete reduction was not carried out because it was clear from the radiogram that the first and second molars were in the line of fracture and would have to be removed.

In treatment there is always a difficulty in controlling the posterior fragment, and in the above described case the only available fixed point was the third molar, whose stability is not always to be relied upon owing to the shape of its roots. It has also been observed that, if the posterior fragment overlaps the anterior fragment, union generally follows, the anterior fragment acting as a resistance against the inward pull of the superior constrictor and mylohyoid on the posterior fragment.

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[1] From *British Dental Journal.*

(iv) *Wiring of the Fragments.*—In a few cases where the fragments cannot be controlled by means of interdental splints, immediate wiring of the fragments may be adopted.

(θ) *Delayed Union.*—Simple fractures of the mandible if properly treated should repair within three months, and if at the end of that period union has not occurred the case must be regarded as one of " delayed union." When there is delayed union there are three possible issues, namely:—

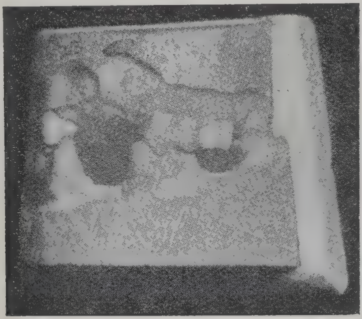

Fig. 879.[1]

(i) Osseous union.

(ii) Union by a band of dense fibrous tissue, the fracture having a slight " give."

(iii) Non-union, the fragments being freely movable.

The commonest cause of delayed union is the presence of septic teeth in the line of fracture. An example is shown in fig. 880. The radiogram was taken three months after injury. The removal of the affected teeth was followed by rapid union.

Occasionally the infection from the teeth leads to extensive rarefaction of the bone, or, if the infection is mild in type, to a sclerosis of the margin of the fragments. Both of these conditions result in non-union.

Another cause of delayed union is the presence of a thin layer of necrosed bone between the fragments. Radiograms of recent fractures sometimes show a thin detached portion of bone between the fragments. This thin layer of bone may become infected and necrosed and so lead to non-union.

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[1] From *British Dental Journal.*

Imperfect reduction of fractures leaving considerable overlapping of the fragments leads to prolonged delay, and so also does non-immobilization of the fragments. The latter condition cannot always be prevented where teeth are missing. With fractures posterior to the last molar tooth the constant movement of the fragment by the superior constrictor of the pharynx is a common cause of delayed union or even non-union.

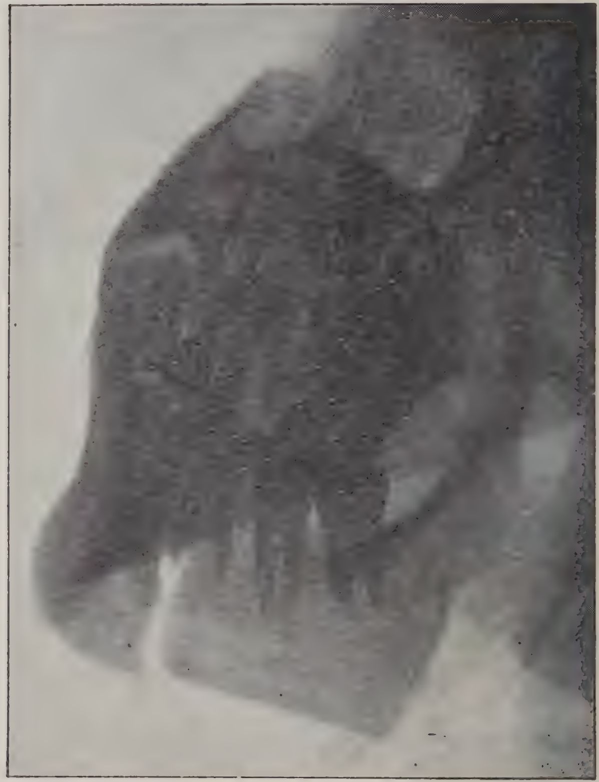

FIG. 880.[1]—Radiogram of a case of "delayed union" showing the root of a tooth in the line of fracture.

Even where the fragments have been immobilized and danger from sepsis has been quickly eliminated union is at times delayed. This is possibly due to defective power of repair on the part of the individual. It has been suggested that in such cases there is defective calcium metabolism, and the administration of thyroid extract has been advised, but this drug was tried at the Croydon War Hospital without any trace of improvement.

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[1] From *British Dental Journal.*

With diabetics, or where there is a history of syphilis, union is at times delayed.

In cases of non-union, sepsis, if present, should be removed, and when the tissues have thoroughly recovered, the ends of the bone should be freshened sufficiently to expose the medulla and the fragments approximated and immobilized either by means of interdental splints or by a wire suture through the bone.

(ι) *Mal-union.*—Where the occlusion is only slightly deranged, the simple operation of " cutting in the bite " will often suffice to correct the malocclusion. In the case of fractures in the region of the last molar tooth and fractures of the ramus the mouth may be " gagged " on the posterior teeth, and these teeth will need to be removed in order to bring the remaining teeth into occlusion. Failure to reduce the fragments correctly may result in marked deformity. For example, in fractures behind the last standing tooth, the posterior fragment may swing forward and the covering muco-periosteum come into contact with the maxillary teeth. Discomfort and perhaps ulceration of the soft tissues follow. The patient, in order to avoid the discomfort, involuntarily brings the jaw over to the injured side and the face becomes markedly deformed. In other words, the patient acquires a " bite of comfort " at the expense of his personal appearance. A similar condition is seen in fractures of the molar region where the anterior fragment has moved to the injured side and union has followed. An attempt to bring the mandible over to the uninjured side is resisted because the soft tissues covering the ramus would then come into contact with the maxillary teeth.

The treatment consists in the removal of one or more of the maxillary molars on the injured side, the patient being encouraged to use the teeth on the uninjured side. In some cases the upward movement of an edentulous posterior fragment is so extreme that the fragment lies external to the alveolar process of the maxilla. In such cases extraction of the teeth is not always sufficient to bring about union, and it is necessary to cut away the bone freely, including the tuberosity. If the mal-union is of long standing, it may be necessary to train the mandible into position, either by means of an engaging flange, or by means of stretching splints. An engaging flange is an apparatus adjusted to the teeth in such a manner as to cause the teeth to occlude in a normal position.

The stretching splint is made as follows:—

(i) Metal caps are adjusted to the maxillary and the mandibular teeth.

(ii) The maxillary splint is covered with a layer of soft composition. A grip of the mandibular teeth on the injured side is obtained and, as the mouth closes, the mandible is firmly brought over to the uninjured side.

(iii) The splints are soldered together; the upper cap is placed in position and the mandible guided into the lower splint.

(iv) The mandible is retained in this position until the patient can easily bring the teeth in and out of the splint.

(v) The splints are unsoldered and the mandible is brought over still further to the uninjured side, the operation being repeated until the correct position is obtained.

(2) FRACTURES OF THE MAXILLA

(*a*) *Causes and Position.*—Fractures of the maxilla are generally caused by great violence. This type of fracture not infrequently results from certain aeroplane accidents. When the machine strikes the ground, the pilot's head is jerked forward and his face comes into contact with the lower part of the frame of the observing screen. Frequently the bone is comminuted; adjacent bones, such as the malar and nasal, are implicated, and the base of the skull may be fractured. When the impacting force strikes the bridge of the nose in a downward direction, as in lift accidents, a transverse fracture of both maxillæ may result, the line of fracture passing high up and involving the infra-orbital plate. In such cases the whole maxilla can be moved "en masse," and there is extreme ecchymosis of the soft tissues. In some cases the bone is forced downwards and backwards and becomes impacted, the bite being "gagged" on the molar teeth. If the impact is received on the lower part of the maxilla, multiple fracture of the lower portion of the bone results.

Separation of the two halves of the maxilla in the median line has been recorded. Lastly, *fracture of portions of the alveolar process and of the tuberosity* occasionally occurs during the extraction of teeth.

(*β*) *Complications.*—These are similar to those met with in fracture of the mandible. The swelling of the soft tissues is, however, often more severe, and there is a greater liability to swelling of the tissues of the naso-pharynx and larynx. The swelling of the air passages must be carefully watched and if necessary laryngotomy performed. Hæmorrhage is at times severe, and it is important to avoid the use of peroxide of hydrogen as the frothing produced may cause obstruction of the air passages.

(γ) *Method of Union.*—Repair in the fractured maxilla appears to be invariably of a fibrous and not of an osseous character. I have examined many cases and have been unable to satisfy myself that osseous union has actually occurred in any of them.

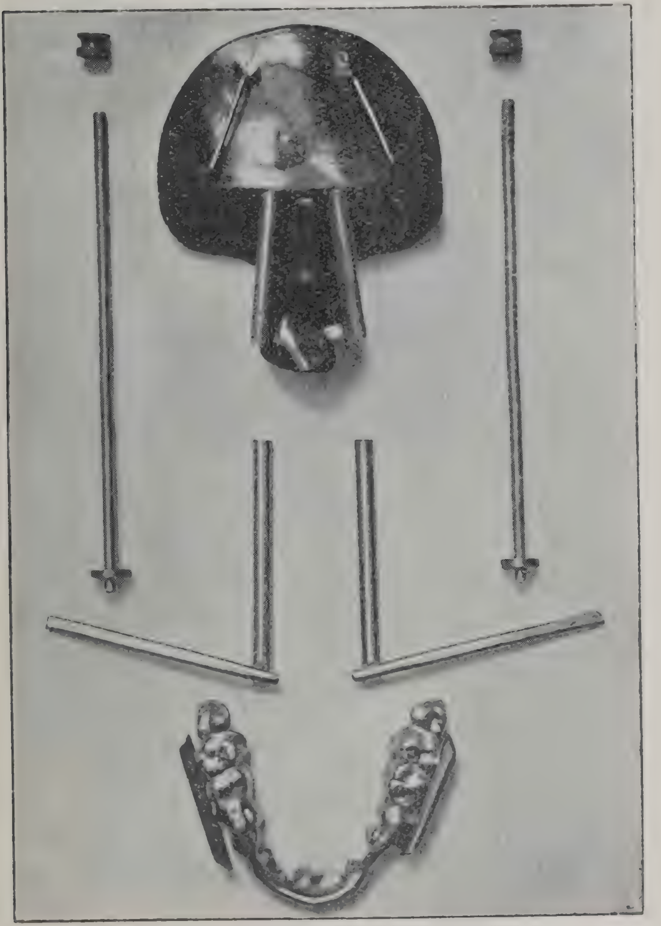

Fig. 881.[1]—Separate parts of the splint.

(δ) *Treatment.*—In **transverse fractures above the level of the roots of the teeth,** the maxilla should be rested by means of a double metal cap splint, which should be retained in position with the aid of a skull and mandibular apparatus.

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[1] From *Brit. Dent. Journ.*

Another method is to cover the maxillary teeth with a metal cap, attaching to the sides of the cap stout wires bent so as to clear the angles of the mouth and lie along the outer side of the cheeks. The wires are then attached to a skull splint.

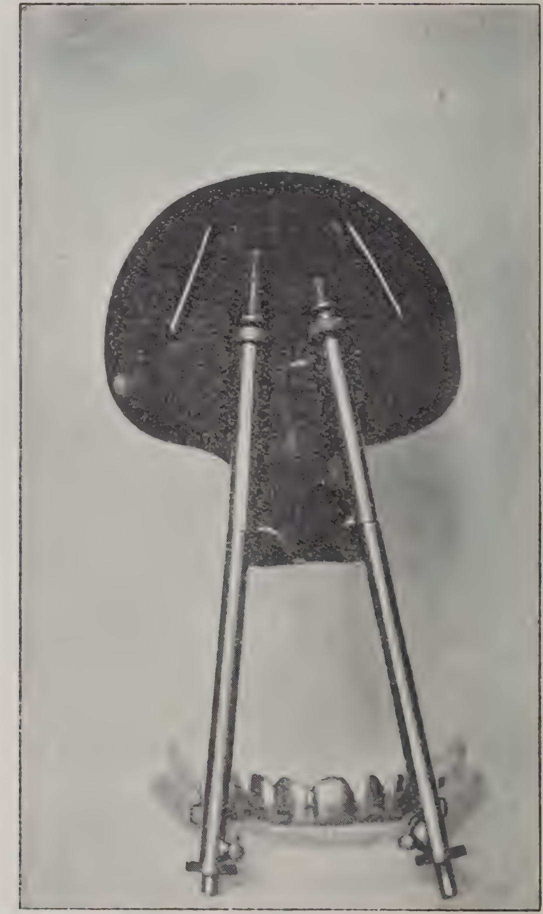

FIG. 882.[1]—The parts of the splint assembled.

A. H. Parrott[2] has introduced a form of splint which keeps the maxilla in correct position and at the same time permits the use of the mandible without putting pressure upon the seat of fracture as the force of mastication is transmitted to the upper border of the orbits.

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[1] From *Brit. Dent. Journ.*

[2] *Brit. Dent. Journ.*, vol. xl, p. 1.

The construction of the splint is as follows:—

(i) A cap splint is fitted over the maxillary teeth and adjusted to the normal bite of the mandibular teeth. On the buccal sides of the cap splint, open tubes are soldered for the insertion of strong metal horizontal bars (fig. 881).

(ii) An impression in modelling composition is taken of the patient's forehead and supra-orbital ridges, the composition being pressed well under the eyebrows and shaped over the bridge of the nose. To the model thus obtained a frontal piece is constructed in vulcanite extending laterally over the eyebrows, downwards over the bridge of the nose. Flat loops are attached to the forehead portion for the passage of straps round and over the head to hold the forehead piece firmly in position (fig. 883).

(iii) To the frontal piece two vertical tubes about 1½ in. in length are attached, and are placed in close apposition to the sides of the nose and as far back as possible to avoid the lines of sight. Further lengths of tubing are cut to reach a little beyond the angles of the mouth; threaded bars are passed through the two sections of the tubes and secured above by a milled nut (see figs. 882 and 883).

(iv) "The forehead cap being fastened in position with vertical tubes and threaded rods *in situ* and the cap splint fixed on the teeth, the horizontal bars inserted into latter are adjusted on the patient and a small plaster key taken of the position of the angle where the vertical tubes and horizontal bars pass each other. These are removed by withdrawal of the threaded bars, and the lower sections of tubing soldered to their respective horizontal bars in exact position; ends are trimmed up and fixation for the whole appliance secured by bookstraps round and over the head and the dental splint being cemented to place. It will be found an advantage to use oval or flattened tubes and bars on the splint, closing the tubes at the posterior end; the bars can then be bent laterally to approximate to the tubes and remain in contact with them without rotation, whilst the key for soldering is taken."

In **multiple fractures through the alveolar portion of the bone,** the teeth involved should be removed and a Gunning splint used until repair has taken place.

The removal of the teeth must be carried out with extreme care. It is often a useful plan to grasp the tooth next to the one to be removed with a pair of forceps and exert pressure in an upward direction during the extraction. If this precaution is not taken undue laceration of the parts may occur. At times the teeth are more easily removed by exerting force in a lateral direction with a straight elevator, and if the muco-periosteum is unduly adherent it should be pared off with suitable instruments.

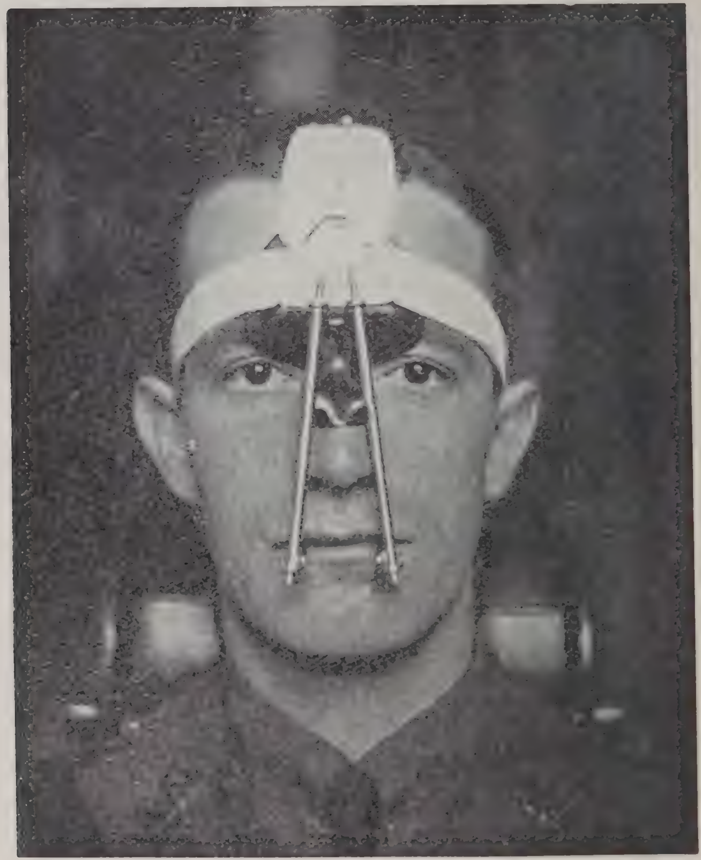

Fig. 883.[1]—Splint in position.

When there is considerable comminution of the teeth the muco-periosteum should be raised from the outer aspect of the bone and a view obtained of the alveolar process; the broken fragments can then be easily removed together with loose pieces or sharp edges of bone, the muco-periosteum being brought together with sutures.

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[1] From *British Dental Journal.*

In the maxilla the line of fracture may run immediately above the roots of the molars, the whole segment of bone being detached. Union under these conditions does not occur, and it is better to remove the whole segment. The muco-periosteum is first reflected from both sides of the bone and the detached portion carefully dissected out, the edges of the soft tissues being brought together with sutures.

The rapidity of the recovery of patients with severe multiple fracture of the maxilla, when the teeth are removed, is remarkable.

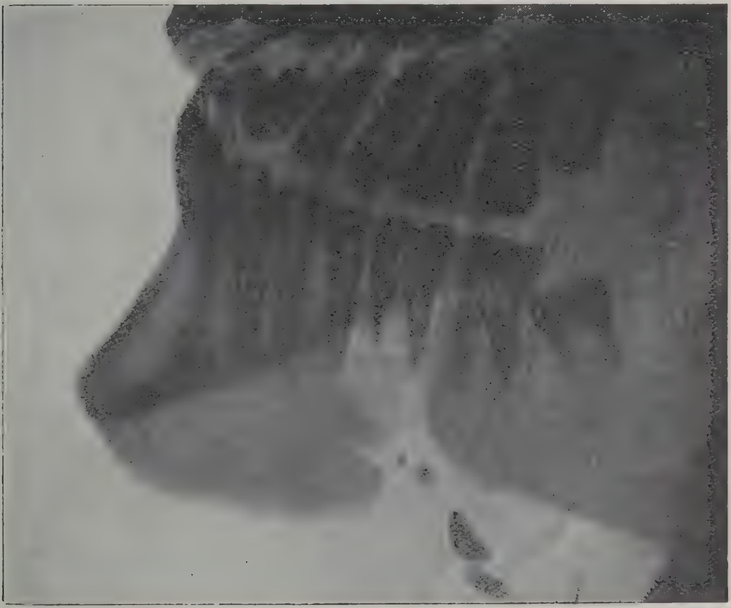

Fig. 884.[1]

Moreover, the teeth if retained are of no value for mastication, the bone around them is liable to necrose, and the maxillary sinus to become infected.

(B) Gunshot Injuries of the Jaws

In times of peace, gunshot injuries of the jaws are of rare occurrence and are mostly met with in men under military training. As these injuries will in the future come more and more under the care of the dental surgeon it is necessary that he should possess some knowledge of their nature and the best methods of treatment.

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[1] From *British Dental Journal.*

In gunshot injuries of the jaws there is frequently considerable loss of tissue and much comminution of the bone, and in these respects they differ from the jaw injuries ordinarily met with in civilian practice. The damage to the bone would seem in some measure to be governed by:—

(i) *The Type of Missile.*—A bullet tends to comminute the bone into smaller fragments than "shrapnel."

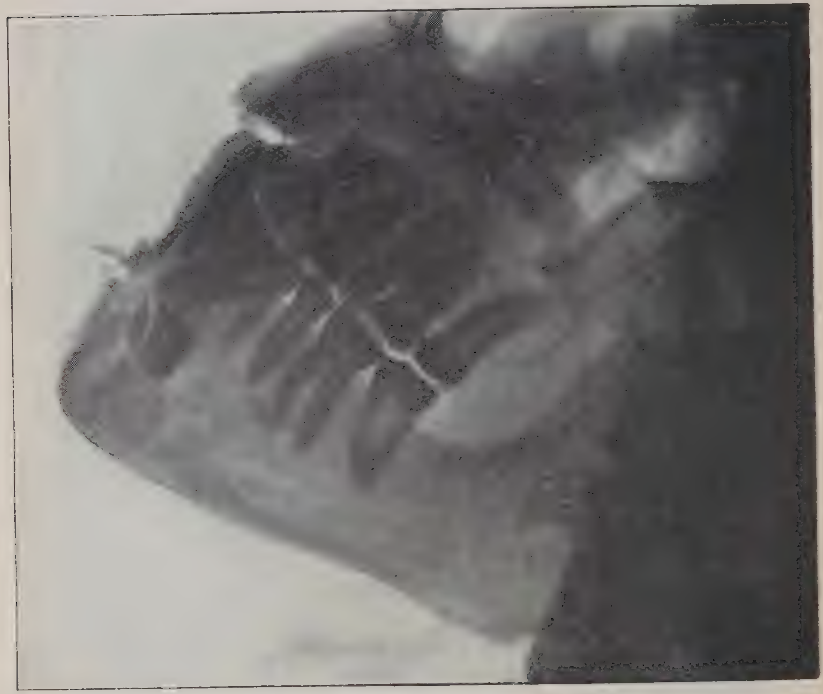

Fig. 885.[1]

(ii) *The Velocity of the Missile.*—As a rule, the higher the velocity the greater the degree of comminution.

(iii) *The Angle of Impact.*—A bullet which strikes the bone at a right angle cuts away the bone in its course, but does not necessarily cause extensive comminution of the remaining fragments. An example is shown in fig. 884. The bullet struck the bone at a right angle near the lower border and carried away the portion below the tooth. The tooth remained in position, being firmly wedged in place by the approximation of the fragments. If a bullet strikes the bone at an oblique angle widespread comminution is caused, but there is little loss of tissue. An example is shown in figs. 885 and 886. The bullet entered the lower lip one inch to the right side of the mid-line and came out on the left side near the level of the hyoid bone at a point midway between the angle of the jaw and the symphysis. The mandible was therefore hit at a very oblique angle,

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[1] From *British Dental Journal.*

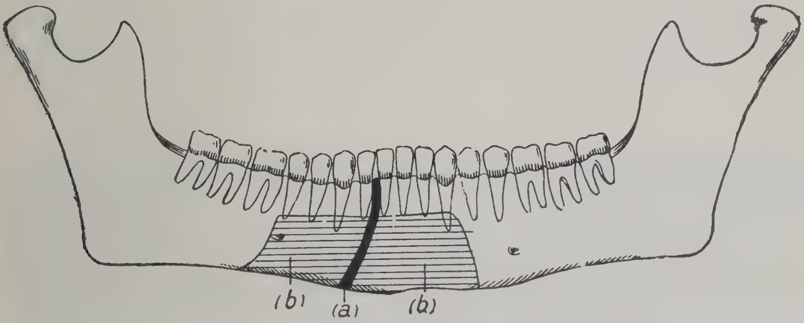

Fig. 886.[1]—(*a*) line of vertical fracture; (*b*) area of comminution.

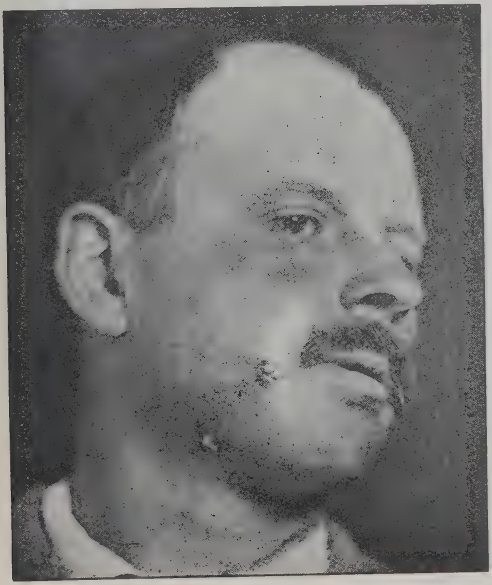

Fig. 887.[1]

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[1] From *British Dental Journal.*

and the bullet took a slightly downward course. The bone was fractured in a vertical direction between the right first and second incisors, the comminution extending beneath the $\overline{54321 | 123}$.

The photograph of the patient shown in fig. 887 depicts the entrance and exit wounds, the former being on the cheek. It would seem from the direction taken by the bullet that the lower border of the mandible was little more than grazed, yet the concussion was sufficient to comminute the bone in the manner shown in fig. 888.

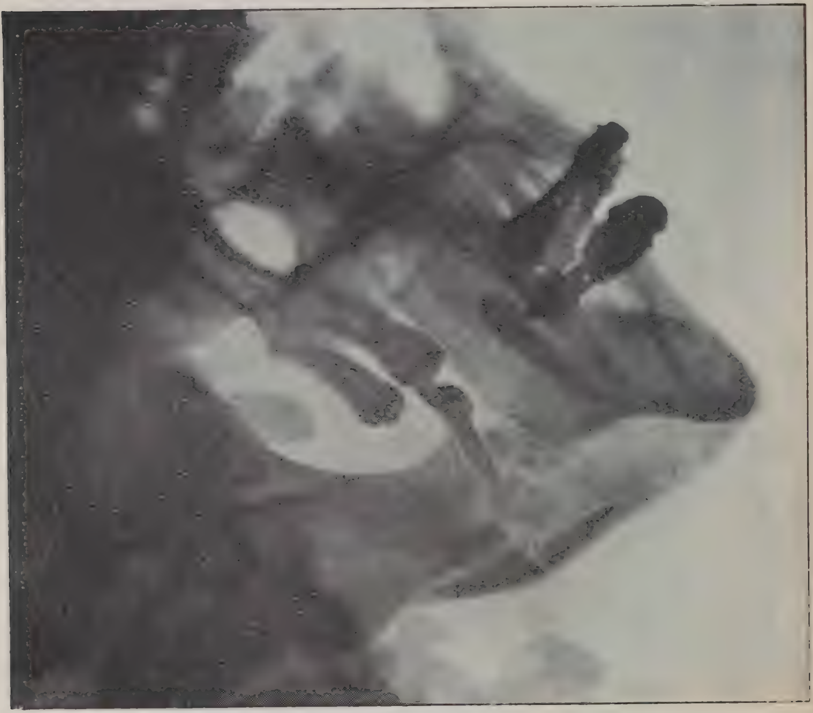

Fig. 888.[1]

(iv) *The Character of the Bone receiving the Impact.*—The harder the bone the greater the degree of comminution. A missile which strikes the hard compact tissue of the lower part of the body of the bone will cause more comminution than one which strikes the alveolar process.

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[1] From *British Dental Journal.*

Treatment

(i) *General Lines of Treatment.*—The general lines of treatment to be adopted are briefly as follows: With much laceration and suppuration of the soft parts, the first object should be to clean the parts and remove the sepsis. For this purpose chloramine and eusol are very efficacious, and the rapidity with which wounds will clear up when treated with these preparations is very remarkable. The mouth is frequently irrigated with peroxide of hydrogen (2 vols.), and the gums swabbed once a day with a 2 per cent. solution of iodine in alcohol. Radiograms of the injured area are next obtained, and here it should be mentioned again that both lateral and antero-posterior views are necessary. The next stage is to examine the patient under an anæsthetic. In cases of recent injury the examination has often to be delayed until the patient has sufficiently recovered from the shock of the injury to undergo anæsthetization with safety. The anæsthetic should be administered with extreme care on account of the swollen condition of the soft parts, and the slightest interference with the passage of air to the lungs must be avoided. Before the operation is commenced the tongue should be brought under control; this is especially necessary if the tongue is partially bound down by adhesions, or if a central fragment exists. The parts are next examined in order to ascertain how far reduction is possible. Teeth bordering on the line of fracture, or communicating with the fracture, are then removed, as well as any septic teeth. While the teeth are being removed, every precaution is taken to prevent blood passing into the pharynx. The extraction should be carried out very cautiously and with as little violence as possible, the teeth being, so to speak, gradually enticed from their sockets. Sharp edges of bone left after the removal of the teeth should be trimmed away and the edges of the muco-periosteum brought into apposition by sutures. The lacerated tissues of the cheek and lips should, if their condition permits, be brought together.

(ii) *The Approximation of the Fragments.*—To obtain osseous union it is essential that the fractured ends of the mandible should be brought into contact, or that living bone should exist in the tissues between the fragments of bone. The approximation of the fragments will result in a narrowing of the arch and some loss of masticating area, but the masticating area can be restored by properly constructed artificial dentures. Some writers who place considerable stress on correct occlusion of the teeth maintain that, if the fractured ends are kept apart, fresh bone will eventually bridge the gap. There is nothing in pathological teaching or experience to support this view, and if bone cells do not exist in the tissues uniting the fragments it is difficult to see how fresh bone is to be created. The cases in which bone has been observed to form have probably been examples of comminution of the tissues with the fragments of bone remaining and forming nuclei for bone growth. Experience shows that many of these cases end, as might be expected, in fibrous union. The choice would therefore seem to lie between a mandible firmly united and capable of bearing the strain of an efficient denture, or the teeth in correct occlusion on a base not capable of bearing the strain of mastication.

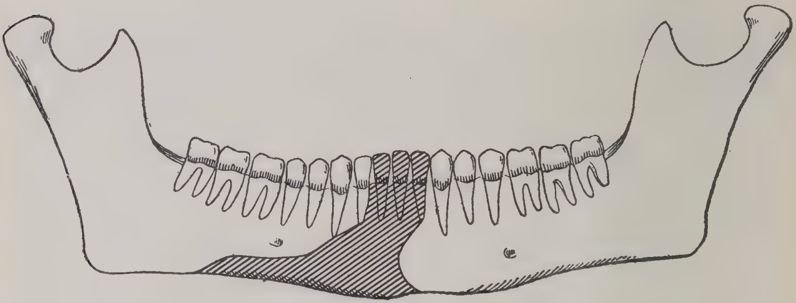

Fig. 889.[1]

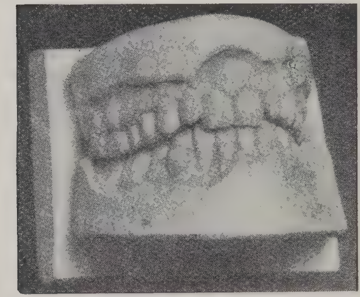

Fig. 890.[1]

In the incisor region the fragments are allowed to approximate, provided that the narrowing does not lead to marked deformity of the face and disorganization of the occlusion. An example may be quoted:—

The bullet carried away the bone, as shown in fig. 889. The parts were approximated, osseous union followed, and occlusion of the teeth was very slightly impaired (fig. 890).

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[1] From *British Dental Journal.*

In the molar region the following method is adopted: The maxillary teeth opposing the teeth of the posterior fragment are removed, allowing the posterior fragment to move forwards and upwards, and the anterior fragment to swing over to the injured side. Where the gap is small, the posterior fragment is released, and a splint made with the anterior fragment in position. Radiograms are then obtained. If the bony parts are found to be in contact, the splint is fixed in position; otherwise the anterior fragment is brought across until contact is obtained. The mandible may thus be mended with the anterior fragment swung over to the injured side, but this is no disadvantage because, with the removal of the splint, there is a tendency for the mandible to adjust itself to functional activity, provided that the so-called "bite of comfort," is avoided (see p. 795).

It is difficult to indicate to what extent the fragments may be allowed to approximate without causing undue deformity, and it is probable that the degree of approximation which is safely attainable differs in individual cases. Good results may be confidently anticipated if the gap is less than half an inch, and, even with gaps up to three-quarters of an inch, approximation may prove successful in some cases. With a wider gap, approximation of the fragments must give way to bone grafts for the formation of an osseous bridge.

(iii) *Fixation of the Fragments.*—Splints similar to those described on p. 789 should be used to fix the fragments. The splints should be adapted as soon as the condition of the tissues permits, but they should not be fixed until the sepsis is completely under control.

(iv) *Cases illustrating Methods of Treatment.*—An idea of the methods to be adopted and the results to be anticipated can perhaps be best conveyed by an account of typical cases:—

(*a*) *Comminuted Fracture of Incisor Region.*—A fracture was caused by a machine-gun bullet which struck the bone on the lower border in the region of the left premolars and passed in a slightly upward direction, emerging on the right side about three-quarters of an inch below and external to the angle of the mouth. On admission three weeks after the injury the teeth present were:—

$$\begin{array}{l|r} 8765432\overset{*}{1} & 12345\overset{*}{6}\overset{*}{7}8 \\ \hline 8765 & 5678 \end{array}$$

There was considerable induration of the soft tissues; a sinus was present under the chin; the pulse-rate was 102, and the temperature 100·4° F. The bullet had carried away the eight anterior teeth.

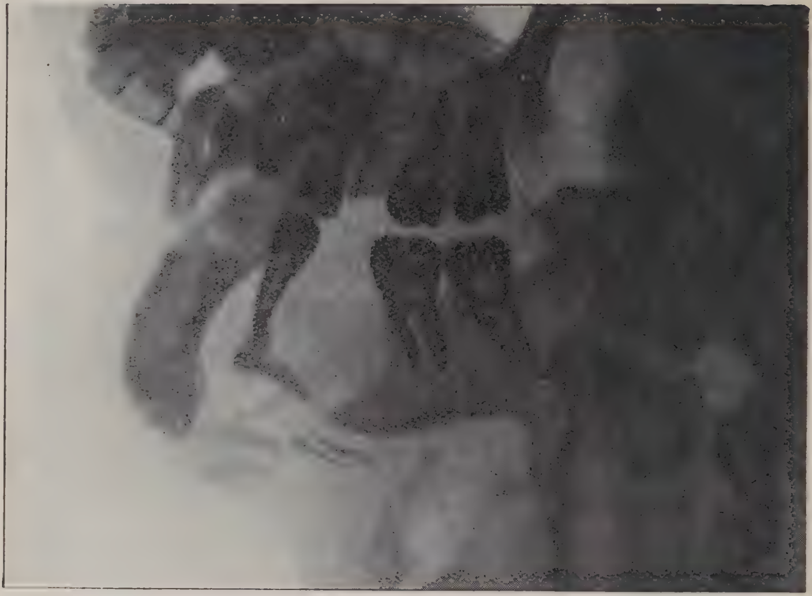

Fig. 891.[1]

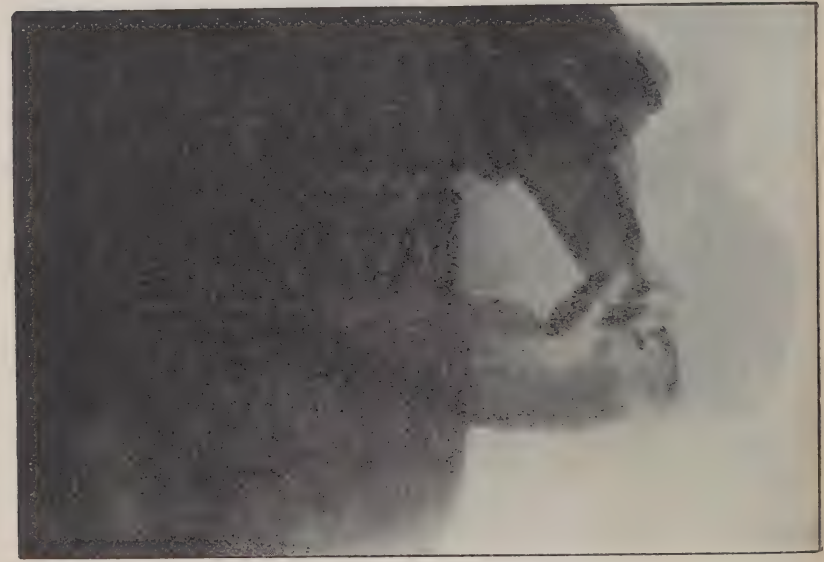

Fig. 892.[1]

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[1] From *British Dental Journal.*

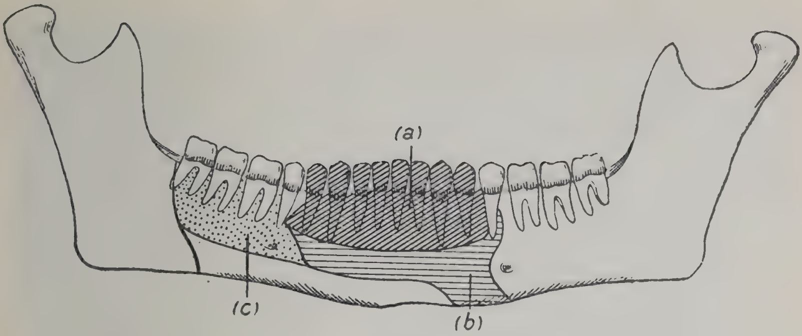

FIG. 893.[1]—(*a*) tissue lost by injury; (*b*) area of comminution; (*c*) area showing marked rarefaction of the bone.

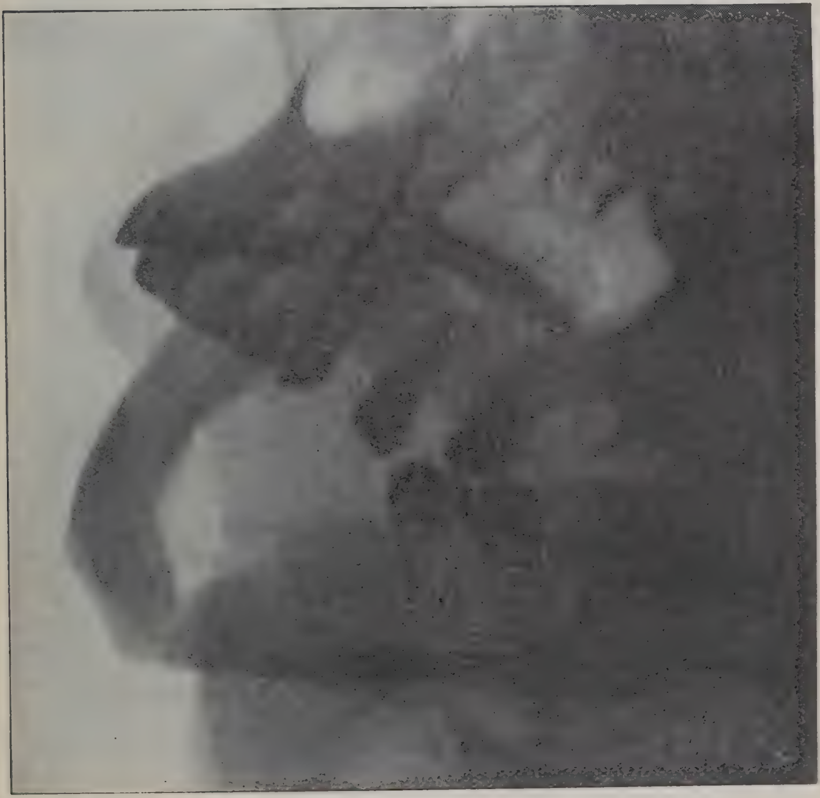

FIG. 894.[1]

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[1] From *British Dental Journal*.

The radiograms of the patient are shown in figs. 891 and 892 and a diagram of the fracture in fig. 893.

The following teeth were removed:—

$$\begin{array}{l|r} 8\quad\quad\overset{*}{2} & 4\;6\;8 \\ \hline 8765 & 5 \end{array}$$

The suppuration in the mouth rapidly disappeared, the fragments in the meantime being allowed to approximate. A splint was adjusted consisting of a vulcanite cap covering the lower gums and attached to a metal cap splint on the maxillary teeth. The condition of the bone four months after the commencement of treatment is shown in fig. 894.

(*b*) *Fracture of the Molar Region with Loss of Tissue.*—The following case is quoted because it is an excellent illustration of (1) the effects of the glancing shot on the bone; (2) the approximation of the fragments to obtain union; (3) fixation in a malposition; and (4) readjustment of the mandible to functional activity.

The bullet entered one inch behind the left angle of the mandible, and emerged through the right side of the bone about midway between the angle and the symphysis and about midway between the lower border of the bone and the alveolar border. On admission, one month after injury, there was a sinus at the site of the exit wound, with a purulent discharge, and a probe passed up the sinus met bare bone. The teeth present were:—

$$\begin{array}{r|l} 7654321 & 1234567 \\ \hline 7654321 & 1234567 \end{array}$$

The mouth was gagged open on the second molars. The radiogram showed comminution of the bone extending backwards to the second molar and forwards to the canine (fig. 895). The following teeth were removed[1]:—

$$\begin{array}{l|l} \overset{*}{8}76 & \\ \hline \overset{*}{8}76543 & \end{array}$$

The sinus was dilated and several fragments of necrosed bone were removed. The fragments were allowed to approximate. The left fragment passed across to the right, and the right or posterior fragment swung forwards. A radiogram taken at this stage showed that there was a gap between the fragments. A splint was then adjusted and the left fragment brought still further to the right to obtain contact with the right or posterior fragment. Good union

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[1] The * denotes that the tooth was unerupted.

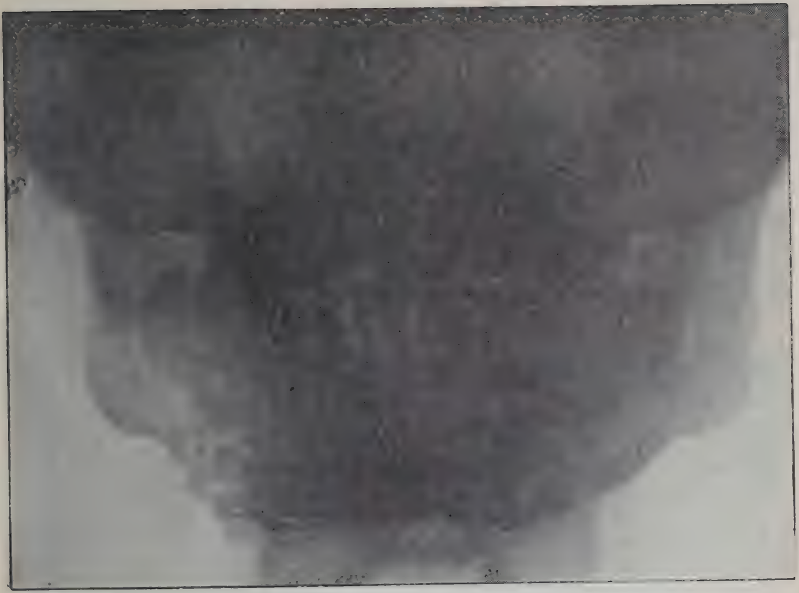

Fig. 895.[1]

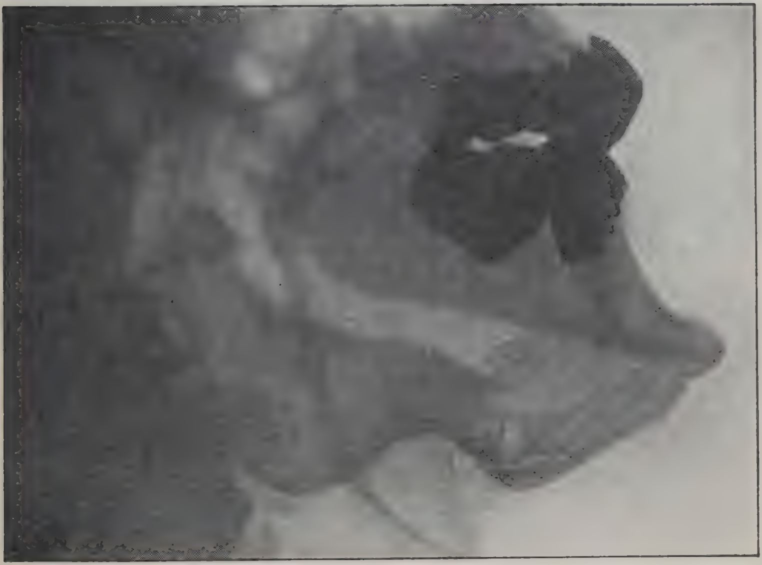

Fig. 896.[1]—Radiogram taken just previous to the removal of the splint, showing (*a*) the forward movement of the posterior fragment, (*b*) the deviation of the anterior fragment to the injured side.

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[1] From *British Dental Journal.*

followed within four months (fig. 896), and within one month of the removal of the splint the teeth on the left side of the mandible were in correct occlusion. A radiogram (fig. 897) taken one year after the injury showed perfect union.

(c) *Fracture in the Region of the Angle and Ramus.*—In many cases the patient's third molars have not erupted, and occasionally a fracture passes through the crypt of this tooth. For this type of case the following treatment is adopted: In the mandible, the second molar is removed and then the unerupted third molar. The necessity for removing the second molar may be questioned, but it must be remembered, firstly, that the removal of the third molar alone would entail considerable injury to the fractured area and, secondly, that the removal of the second molar allows the operation to be carried out with a minimum of damage to the bone. In the maxilla, the second and third molars are removed for the following reason: Where there is loss of tissue, the ramus moves forward and the soft tissues are brought into contact with the maxillary teeth. The result is that the patient, in order to obtain a "bite of comfort," involuntarily brings the mandible over to the injured side and the teeth are not in occlusion; further, in many cases definite

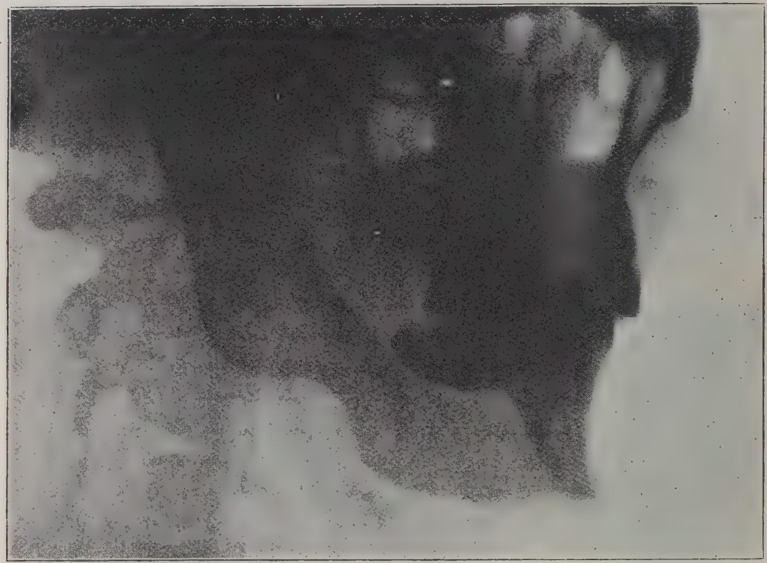

FIG. 897.—Radiogram taken one year after the injury, with dentures in position. The "imperfect bone" has been replaced by lamellar bone. The teeth are in correct occlusion.

ulceration of the soft tissues follows. The removal of the second molar avoids this sequela. If the third molar is retained, a similar condition is likely to follow when this tooth erupts.

A patient was injured on July 1, 1916, and admitted to hospital on July 13. A bullet had entered half an inch above the right ala of the nose and emerged close behind the angle of the mandible on the same side. There was a deep flesh wound at the point of exit; all the teeth, with the exception of the left third molars, were present; there was no malocclusion. The radiogram showed a severe comminuted fracture of the mandible and a fracture through the maxilla in the region of the molars.

The diagram (fig. 898) will help to convey an idea of the extent of injury to the mandible. The greater part of the ramus, as shown by the shaded area, was severely comminuted; the portion (*a*) was displaced backwards; there was a fracture running from the sigmoid notch downwards and backwards to the posterior border of the ramus; a thin layer of the posterior border (*b*) had escaped comminution.

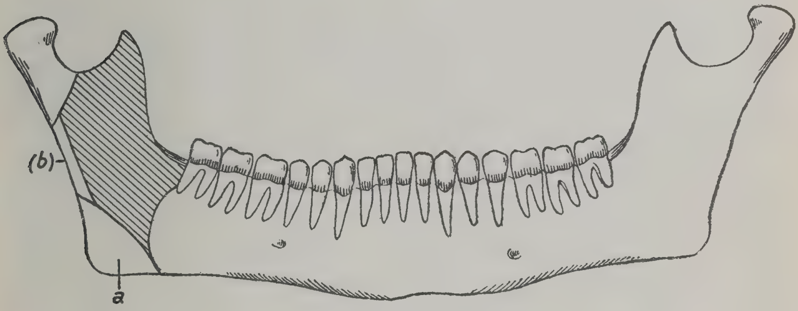

Fig. 898.[1]

At the operation it was found that the maxillary first molar was fractured into three pieces, and as the alveolar process carrying this and the remaining molar was quite loose it was removed. The mandibular first molar, which was septic, was also removed, together with the second molar and the unerupted third molar. The parts were frequently irrigated, and the patient made a complete recovery by October 15, when the occlusion of the teeth was as shown in fig. 899.

In severe comminuted fractures where it is doubtful whether the tissue remaining is sufficient to obtain union, the mandible should be brought into correct position and fixed for a period of at least three months. Early and efficient treatment of the sepsis produces exceedingly good results. An instance is given below.

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[1] From *British Dental Journal*.

The patient was injured September 11, 1916, and admitted October 2. The injury was caused by a fragment of shell which struck the mandible behind the right angle. The mandible had deviated slightly to the left; there was considerable swelling in the

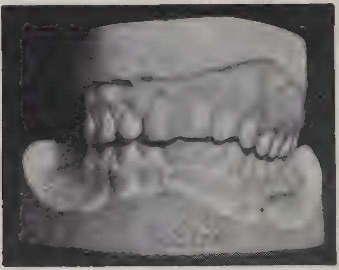

Fig. 899.[1]

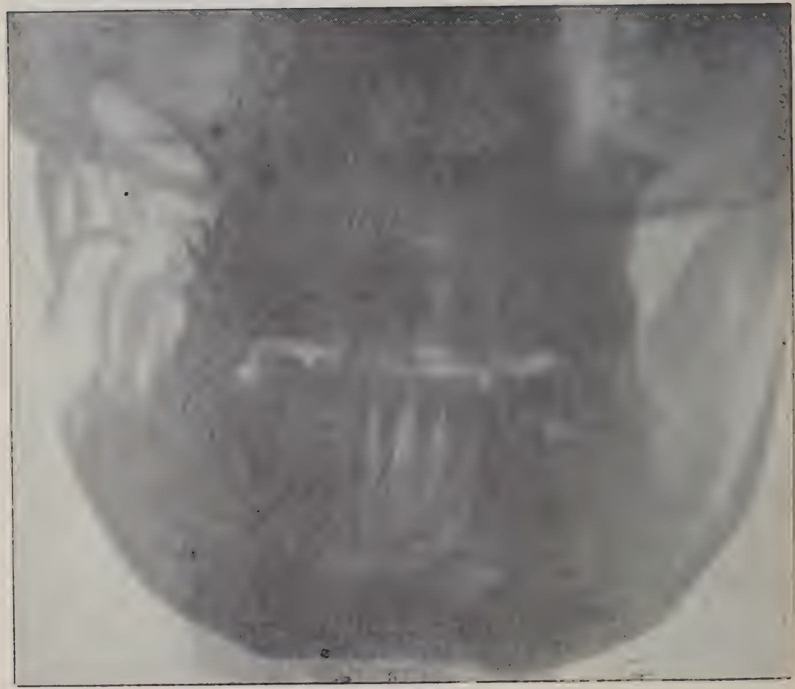

Fig. 900.[1]

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[1] From *British Dental Journal.*

neighbourhood of the wound with a sinus freely discharging purulent pus. The radiogram (fig. 900) showed a severe comminuted fracture of the right ramus.

On October 4 the following teeth were removed:—

$$\begin{array}{r|l} 876 & \overset{*}{4} \\ \hline 87 & \end{array}$$

The sinus, which was found to lead direct to the socket of the third molar, was scraped and several pieces of necrosed bone were removed through the wound in the mouth. The wounds continued to discharge freely, and it was not considered advisable to insert a splint until October 26. By the end of November the sinus had closed, and on December 7 the splint was fixed and not removed until February 12, when union was complete and the teeth were in perfect occlusion. A radiogram taken at this date is shown in fig. 901.

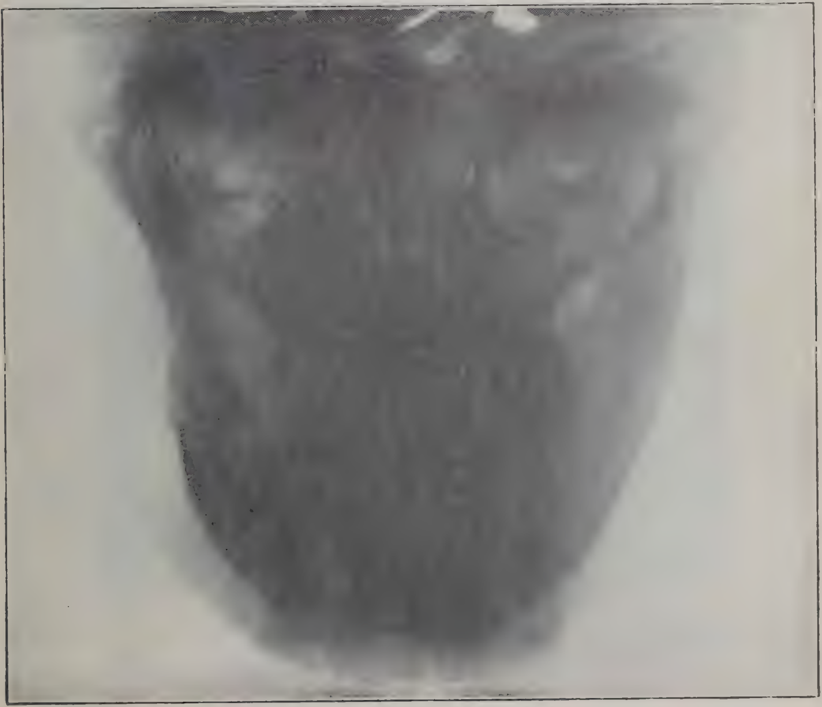

Fig. 901.

In cases where there is considerable loss of tissue the fragments should be united with a bone-graft.

CHAPTER XXX

Necrosis of the Jaws

Causes—Signs and Symptoms—Diagnosis—Treatment

Necrosis affecting the jaws may be limited to a small fragment of the alveolar process, or may involve the greater part of the bone. Necrosis is more common in the mandible than in the maxilla, on account of the exposed position of the former, its smaller blood supply, and the fact that it is composed mainly of compact tissue.

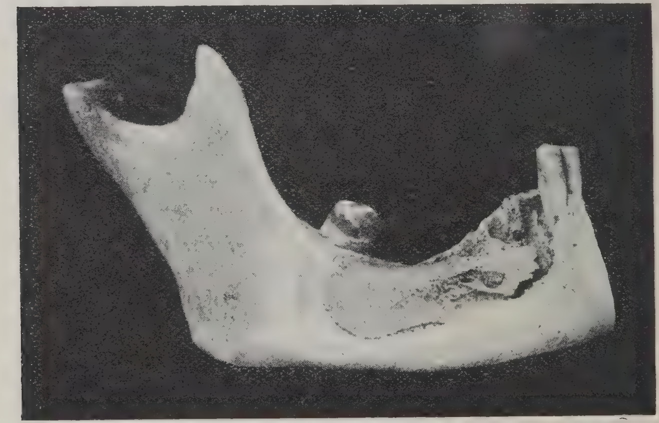

Fig. 902.—Necrosis of the mandible involving the body of the bone. The necrosis was due to infection in connection with the canine.

(A) CAUSES

(*a*) **Bacterial Poisons.**—In the majority of cases, necrosis of the jaws is the result of septic or infective processes arising in connection with the teeth. The *infection may reach the bone viâ the teeth or their sockets*, and examples of this are met with in the necrosis which occasionally follows septic periodontitis. The necrosis may be limited to the alveolar process, or may involve the body of the bone (fig. 902). How severe a condition can arise will be seen from the following case reported by W. H. Dolamore.[1] It occurred in a little boy, aged 4, and arose in the region of the mandibular left deciduous molars. A general supporting treatment was carried out with the local use of antiseptic and deodorant mouth-washes. At the end of ten months the necrosed bone was removed, and the extent of the disease can be gleaned from fig. 903. The radiogram seen in fig. 904 shows the extent to which new bone had been formed from the periosteum.

A case is reported from Breward Neale,[2] in which an extensive necrosis of the mandible was attributed to a dental operation.

"The patient, a medical man, consulted a dental practitioner on account of great pain from a mandibular right canine in which the pulp was exposed. At the first visit the pulp was dressed with a devitalizing agent; at the second visit a portion of the pulp was extirpated; at the third visit the root and crown were filled, but a flexible drill was broken in the canal. The position of affairs was made clear to the patient, and he went away. On the fourth day he experienced great pain, and he attended and asked for the tooth to be removed, but as it was thought possible to save the tooth an opening was made through the alveolus with a view of relieving the pain. The patient attended the next day, again hoping to have the troublesome tooth removed, but the practitioner still thought removal of the root unnecessary, and excised the crown. On the sixth day, however, the root was extracted, but no relief following, the case passed into the hands of his surgical colleagues."

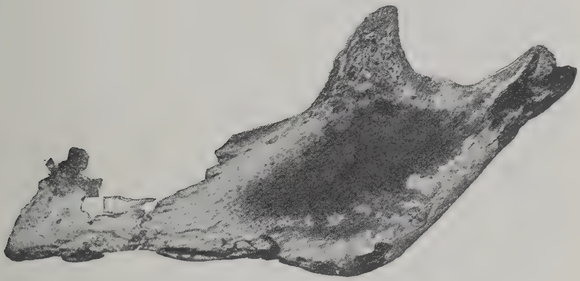

Fig. 903.[3]

The patient then went into hospital. The pain and swelling increased and the submaxillary and submental regions became swollen and brawny. Free incisions to the bone gave little relief. The condition became very grave, the whole mandible becoming involved as far as the angle and the outline of the neck being obliterated. The patient fortunately recovered, but, at different times, forty-nine sequestra were removed. The average size of the larger sequestra was 1 in. long, $\frac{1}{4}$ in. wide and $\frac{1}{16}$ in. thick.

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[1] *Journ. Brit. Dent. Assoc.*, vol. xxi, p. 3.

[2] *Trans. Odonto. Soc.*, vol. xxxii, p. 146.

[3] From *Journ. Brit. Dent. Assoc.*

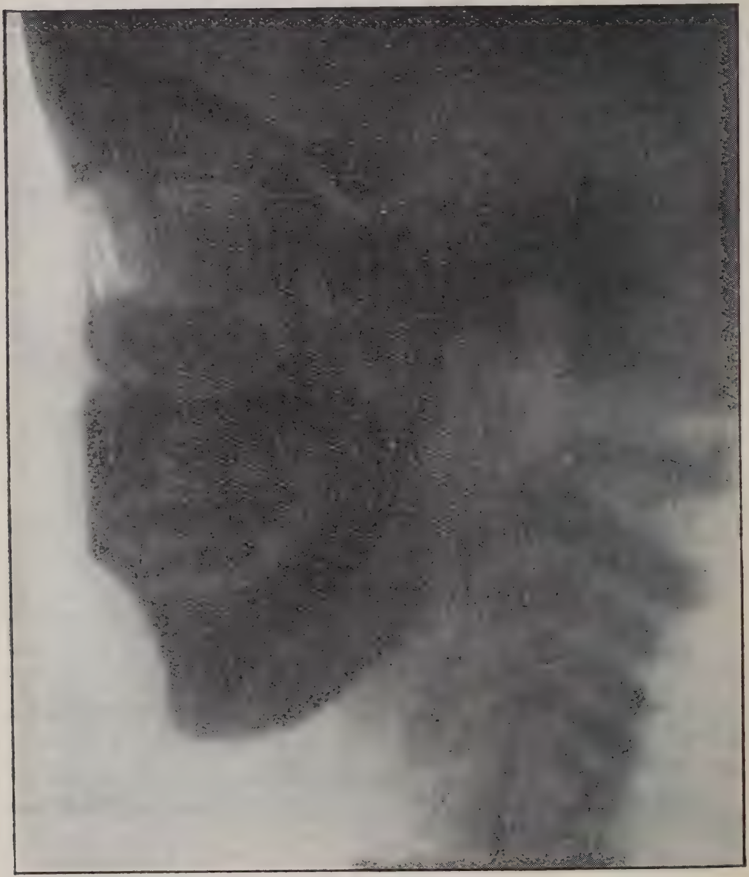

FIG. 904.[1]

In children, whose resistance has been lowered by bad hygiene or acute illness, *the infection may reach the bone viâ the gum.* The necrosis seen in gangrenous stomatitis is an example of this mode of infection.

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[1] From *Journ. Brit. Dent. Assoc.*

A third way in which the *bacterial toxins may reach the bone is by the blood-stream.* H. A. T. Fairbank considers that infection through the blood-stream is more common than is generally supposed; the region of the angle and the ramus are the parts usually affected. The clinical condition is similar to "acute necrosis" of the long bones. Fairbank quotes the following case as typical of this type of infection: "A boy was brought to the Children's Hospital, Great Ormond Street, with a brawny swelling over the lower border of his mandible opposite the molar region. Each of the two deciduous molars on that side had a small carious cavity, though there was no sign of periodontitis, and the gums were normal. The swelling was incised through the skin and pus evacuated from beneath the periosteum of the jaw. One of the molars was removed, as it was possibly the cause of the trouble. Except for the superficial caries, the tooth was absolutely normal, and the pulp was healthy."

The necrosis, occurring as a sequela **of the exanthematous fevers,** is probably due to bacterial infection invading the bone from the mouth or the blood, and is in no way a specific effect of the fevers. The septic condition of the mouth present during the acute stages of the exanthematous fevers, combined with the lowered resistance of the individual, and the liability to injury in the process of cleaning the gums and the throat, all favour the occurrence of necrosis. H. Austen,[1] in an extended experience at the Western Fever Hospital, is of the opinion that necrosis always begins during the acute stage of the illness. In five thousand patients treated at the Western Fever Hospital, all of whom were under observation for at least eight weeks, the cases of necrosis that occurred could all be referred to the acute stage of the illness, not one having arisen during convalescence.

Necrosis is more common in connection with scarlet fever than with measles and is rarely met with in small-pox. In scarlet fever, necrosis is mainly met with in cases in which severe throat symptoms are present, and is usually first clinically recognized in the second and third weeks of illness. Children between the ages of 4 and 6 are the most frequent sufferers, but it may occur in younger and older patients.

Austen states that—

"Scarlatina necrosis of the jaw is most frequent in the lower incisor region on the labial side. It is, however, often seen in the premolar and molar regions on the buccal aspects. In the former situation it is usually symmetrical, less frequently so in the latter. In one case, under the care of a colleague, necrosis occurred on the inside of the ramus, well behind the last molar tooth, and not involving the alveolus in any way. The necrosis may involve the bone forming the sockets of the deciduous teeth only, or more rarely, and especially in the lower incisor region, cause destruction of the bone enclosing the sacs of the permanent teeth.[1] The sequestrum usually takes two or three weeks to separate. The mortality of the cases in which necrosis of the jaw takes place is high, partly from the usually intrinsically severe nature of these cases, partly from aggravation of the symptoms caused by the necrosis. In the worst cases, the mouth becomes horribly foul, and the patient soon dies of pyæmia or septic broncho-pneumonia. Two causes may be clinically recognized for this necrosis of the jaw in scarlet fever. Firstly, exposure of the bone by ulceration of the gum, seen in severe stomatitis, already alluded to. Secondly, and more frequently, injury. The latter cause may appear a somewhat remarkable one to anyone not acquainted clinically with this disease."

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[1] *Dental Record,* June, 1896.

"For the efficient treatment of the very severe throat condition present in so many cases of scarlet fever, constant applications to the fauces of antiseptics, &c., become necessary, with removal of any secretions likely to decompose or lead to injury. This is done by syringing, spraying, or swabbing, the latter procedure being most effective. These methods, however, necessitate the introduction into the mouth of bone or vulcanite syringe nozzles, spatulas to depress the tongue, occasionally a cork wrapped with lint to gag the mouth open temporarily. However great be the care employed, it is almost impossible in some children to avoid injury to the deciduous teeth. The child will bite the spatula or the nozzle of the feeding vessel, &c., until the teeth become quite loose and fall out, the septic state of the mouth then causing ulceration, and ultimately necrosis of some part of the socket. I have been many times surprised at the very slight pressure with a spatula, or other implement used in examining the throat, that will loosen or extract the teeth in these cases, even when employed with the greatest care and gentleness. Even short of extraction of these teeth I am convinced from clinical observation that necrosis of the alveolus often arises merely from pressure on the crowns, and that not undue in amount. In severe cases in which extensive necrosis appears, I am convinced that it is best to leave the fauces entirely alone, and to feed the child solely with the nasal tube, as if the treatment be persevered in the case will only go from bad to worse."

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[1] It is possible that some cases where destruction of the permanent tooth sac occurs may be overlooked, owing to the fact that the condition so often proves fatal.

Austen's remarks have been quoted fully because they seem to throw much light upon this hitherto obscure condition. During the acute stage a piece of bone may die from either ulceration or injury, and may remain hidden beneath the gum for some time, the true condition only becoming manifest when the bone has separated from the living bone and is being exfoliated. Exanthematous necrosis so called would therefore seem to be not a secondary specific sequel, but rather a condition which arises during the acute stage.

(*b*) **Chemical Poisons.**—*Arsenious Acid.*—The commonest example of necrosis traceable to chemical poisoning is that which is caused by the escape of arsenious acid used for devitalizing the pulp. The poison may act directly on the gum, or may escape through the apical foramen. Usually, the necrosis is not extensive, but, with superimposed bacterial infection, a considerable portion of the bone may become involved.

Mercury.—A long course of mercury or the constant inhalation of mercurial fumes may cause necrosis. This form of necrosis is uncommon at the present day, as mercury is not now given in quantities sufficient to produce salivation, and operators employed in the manufacture of looking-glasses are not subjected to the same risks as formerly. Mercury causes necrosis by setting up an acute suppurative periostitis.

Phosphorus.—This form of necrosis was first described by Lorinser, of Vienna, while Wilks was the first in this country to draw attention to the subject. It is a severe form of disease and may affect both jaws, though usually only one at a time[1] is affected. In the early stages it is slow in its progress. The condition is one of cario-necrosis and differs in no respect from the same lesion seen in other bones and arising from various causes.

A mandible showing extensive necrosis due to phosphorus poisoning is shown in fig. 905.

This form of necrosis is nearly always seen in those subjected to the fumes of phosphorus. It is to be noted that the disease is mainly met with in those engaged in the dangerous parts of the manufacture of matches, namely, "mixing," "dipping," "drying," and "boxing."

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[1] In 51 cases collected by von Bibra, 21 occurred in the maxilla, 25 in the mandible, and in 5 cases both jaws were involved.

The fumes emanating from phosphorus consist principally of phosphorus anhydride (P_2O_3) and phosphoric anhydride (P_2O_5). These fumes are probably dissolved in the saliva. (1) The action may be purely local, in which case the irritant finds its way through a septic pulp or wound of the bone and sets up an inflammation of the periosteum, followed by suppuration and necrosis; or (2) the phosphorus fumes produce a general lowering of the resistance of the individual, and also locally, by their irritant action, weaken the nutrition of the bone and render it more liable to attack by micro-organisms.

The sequestrum from cases of this form of necrosis is often peculiar, owing to a deposit known as the "pumice-stone" deposit. This is found in sequestra from the mandible, but not in those from the maxilla. It is formed from the periosteum, but is so closely adherent to the sequestrum as to be generally brought away with it. A point of interest in regard to the structure of the deposit is that the Haversian canals are larger than in normal bone; they run at right angles to the general direction of the bone, and not parallel to it; they interlace with one another, and in some places form sac-like expansions. Although this peculiar deposit is generally to be found in cases of phosphorus, it may occur in other forms of necrosis.

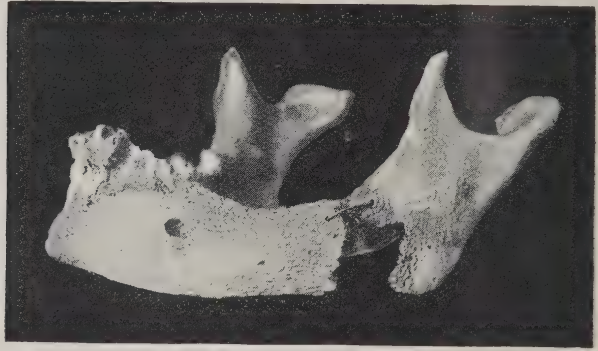

FIG. 905.—Extensive necrosis of the mandible occurring in a lucifer match maker. In this specimen the "pumice-stone" deposit is not present in the sequestrum.

The *symptoms* of this disease generally commence with toothache, which is at first local and constant, and later becomes more severe and erratic, the pain shooting to the side of the head and towards the shoulder. The disease is at first subacute. The gums become swollen and livid, the swelling and tenderness increase, and suppuration eventually takes place. The skin over the part becomes red, tense, and distended. Bronchial and pulmonary symptoms from irritation may develop, while later, during the advent of suppuration, there is often well-marked pyrexia, accompanied by rigors. The sufferings of the patient are much relieved by the discharge of the pus.

Prognosis.—If the disease is not too far advanced and the treatment is prompt, the prognosis is favourable. In about 83 per cent. of the patients attacked with this disease recovery takes place.

The prophylactic treatment is the most important. The yellow phosphorus is the dangerous form, and its use is now abandoned in this country in match-making. Since the enforcement in lucifer match factories of special rules relating to general hygiene, regular medical and dental inspection, &c., the number of operators attacked by phosphorus necrosis has considerably decreased. In the years 1893 to 1899, previous to the institution of the special rules, 37 cases of phosphorus poisoning occurred among 1,908 persons employed in the dangerous processes, while since the institution of the rules, namely, 1900 to 1907, the incidence has been 13 in 1,378.

(*c*) **Trauma.**—Necrosis from traumatic causes is only liable to occur when the injury leads to a comminution of the bone in such a way that the fragment is cut off from its blood supply. Necrosis of small portions of the alveolar process following extraction often occurs in this way. In the majority of cases of necrosis following trauma, however, the death of the tissue is due to septic infection.

(*d*) **Tubercle.**—Tuberculosis of the jaws is a rare and intractable disease. It is usually met with in patients affected with tuberculosis of the lungs. The disease usually starts in other parts of the mouth and spreads to the gums and teeth, more rarely the primary lesion is in the alveolar process. In a case under my care, the seat of trouble was a mandibular left second premolar, and the disease, in spite of treatment, involved the whole of the body of the bone on that side. An interesting case is recorded by Partsch,[1] in which the primary lesion was a tuberculous periodontitis, the bacilli having gained access through a carious mandibular first molar.

Injury of the bone from tooth extraction in patients with active phthisis is liable to be followed by necrosis; the death of the bone may be due to the inability of the tissues to react to the injury, or to infection of the bone by sputum.

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[1] *Deutsche med. Woch.*, September 22, 1904 (translated in *Brit. Dent. Journ.*, vol. xxvi, p. 657).

According to Carl Zandy,[1] tuberculosis of the alveolar process usually develops between the ages of 15 and 20, and affects males more frequently than females.

(*e*) **Syphilis.**—Necrosis from syphilis occurs in the tertiary stage, a common seat being the hard palate, but any part of the jaws may be affected. The primary cause is invariably injury to the bone from trauma, or sepsis; the part thus injured becomes the seat of a gummatous infiltration or a proliferative osteitis. The mandible is said to be less liable to syphilitic disease than the maxilla.

(B) SIGNS AND SYMPTOMS

Necrosis in the early stages simulates periostitis. The gums become much swollen and tender, and suppuration occurs, the pus discharging and leaving sinuses; the teeth become very loose and pus oozes up the sides. The skin may be shiny, red, œdematous, and the breath fœtid. In severe cases, gangrene may ensue, with fatal results.

(C) DIAGNOSIS

Necrosis is apt to be confounded with epithelioma of the gums which has spread to the maxillary sinus (creeping epithelioma), or it may be mistaken for sarcoma. Streptothrix infection also simulates necrosis. Dead bone can be recognized by the grating sensation produced when a probe, on being passed down a sinus, impinges upon the bone. In children the sequestrum frequently involves the permanent teeth, while in cases of phosphorus necrosis it presents a peculiar appearance known as the pumice-stone deposit, which has already been referred to. After removal of the sequestrum in the maxilla, the tissue of repair is usually fibrous in character, no new bone being formed; whereas, in the mandible, a considerable amount of new osseous tissue is formed, and in a notable case recorded by W. Savory (*Roy. Med. Chir. Soc. Trans.*, vol. lvii, pp. 187-191) the whole jaw was removed from a lad aged 18, and six months afterwards, when death occurred, almost a new mandible had formed.

(D) TREATMENT

In the early inflammatory stages, any cause, local or general, should be removed and fomentations applied. A good purge must be given, and in addition, large doses of iodide of potassium are recommended, opium being added when there is much pain. Should destruction of the bone seem probable, free incisions must be made to relieve tension, while the teeth in the area involved should be removed. The health must be supported, and, if solid food cannot be taken, fluids must be given. If the bone is necrosed, but immovable, free drainage should be established and the case left alone for Nature to throw off the sequestrum. If more than one sinus exists, they should be connected and the parts constantly irrigated. As soon as the bone is loose it must be removed with suitable instruments. When the necrosis involves large portions of the jaw, surgical measures may be called for, but should not be adopted until the new bone developed from the periosteum is sufficiently complete to maintain the form of the jaw. For the method of procedure the reader is referred to one of the manuals of surgery.

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[1] *Arch. f. klin. Chir.*, iii, p. 178.

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CHAPTER XXXI

Suppuration of the Maxillary Sinus—Empyema Antri

The Anatomy of the Maxillary Sinus—the Causes of Suppuration—Bacteriology—Signs and Symptoms—Complications—Diagnosis—Treatment.

The chief disease of the maxillary sinus which comes under the notice of the dental surgeon is suppuration of the lining membrane.

(A) ANATOMY OF THE MAXILLARY SINUS

The maxillary sinus varies considerably both in size and shape, but these variations can be roughly grouped into three classes, namely, the normal, the small or contracted, and the large or expanded, the size being governed by the amount of tissue between the teeth and the floor of the sinus. The dimensions may be considered as **normal** when the floor of the sinus is approximately level with the floor of the nose; **contracted** when the floor is above, and **expanded** when the floor is below that of the nasal fossa.

The normal sinus extends from the first premolar to the tuberosity of the maxilla. The deepest portion lies opposite the roots of the second premolar and first molar, and from this point forwards and backwards the amount of bone between the teeth and the floor of the sinus increases in thickness. In the expanded sinus the amount of bone which covers the roots of the teeth is decreased, and the roots form projections on the floor of the cavity; the molar roots mostly forming these projections, the premolars less frequently. It is often overlooked that the third molar is closely related to the sinus, but the knowledge of this fact is of the greatest importance in treatment of cases where suppuration of the sinus is suspected to be of dental origin. In the contracted sinus, the amount of tissue between the teeth and the floor of the cavity is considerably increased.

The capacity of the sinus varies greatly. Those of small size may be capable of containing little more than 1 drachm of fluid; while those of the large size may hold as much as 8 drachms. The two sinuses in the same individual may also vary considerably in size. The cavity in many cases is crossed by septa, which, as a rule, run along the floor, the most common situation being between the second and third molars. The septa along the floor may be continued up the outer wall, practically dividing the cavity into two parts.

The sinus may extend into the body of the malar bone. "Deep pockets or fossæ are met with in various parts of the cavity, particularly at the anterior and posterior corners and along the anterior wall immediately beneath the orbital plate. Sometimes a bony canal terminates in a *cul-de-sac* beneath the orbital plate in the nasal corner of the anterior wall." The average dimensions of the maxillary sinus are: Vertical height 1½ in., transverse breadth 1 in., antero-posterior depth 1¼ in.

Normally the sinus opens into the middle meatus towards the anterior part of the cavity. In about 10 per cent. of specimens there is an accessory opening or possibly two. These accessory openings, which are usually situated further back and on a lower level, are, as a rule, larger and more circular than the normal ostium.

A. S. Underwood,[1] who examined about 150 skulls of all ages and both sexes by transillumination, found that the sinus varies considerably in point of size and position, and suggested that its size and position may be entirely governed by the eruption, growth and subsequent loss of teeth. The molars and second premolars are almost always in relation to the cavity, the first premolar often and the canine rarely.

The relation of the teeth to the sinus depends on the size of the cavity. When the sinus is of exceptional size the canine may project in the floor of the cavity, while, in unusually small cavities, only the second and third molars are in relation with the floor.

Clinically, the size of the sinus may be gauged by the fulness of the facial and nasal walls. As a rule, the more these walls are depressed the smaller is the cavity of the sinus.

(B) CAUSES OF SUPPURATION

(*a*) **Trauma.**—Injury to the sinus from direct violence, such as a blow on the cheek, or from fracture of the bone, is seldom followed by suppuration unless a bacterial infection is superimposed. Cases of suppuration of the maxillary sinus in infants, reported to be the result of injury at birth,[2] are probably cases of acute osteo-myelitis.

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[1] *Brit. Med. Journ.*, August 22, 1908, p. 463.

[2] See case recorded by D'Arcy Power, *Brit. Med. Journ.*, September 25, 1897.

(*b*) **Bacterial Toxins.**—Injury to the mucous membrane by septic infection, either from the teeth or the nasal fossa, is by far the commonest cause of suppuration.

The Teeth.—The roots of the canine, premolars, and molars may project into the sinus, and, when this is the case, direct extension of a dento-alveolar abscess from any of these teeth may infect the lining membrane, but usually the second premolar and first molar are the offending teeth. Direct infection may be due to the penetration of a septic tooth or any other foreign body. The infection may arise from a dental cyst suppurating and opening into the cavity, but such cases are rare (see p. 620). One frequent source of infection, but one that is constantly overlooked, is from chronic general periodontitis (pyorrhœa alveolaris). In this condition the septic infection spreads from the periodontal membrane into the bone and thence to the cavity. In one case recorded by J. J. Kekwick[1] the tubercle bacillus was present in the pus, the local tuberculosis being started by a periodontitis in connection with a second premolar.

Opinions vary as to the relation which the amount of tissue between the roots of the teeth and the floor of the sinus bears to the liability to infection. Some authors consider that the thinner the bone the greater the liability to infection; others hold that the infection is due more to the infection of the bone generally than to direct extension from the teeth into the cavity.

The Nasal Fossa.—Extension of infection from the nasal fossa is the commonest cause of suppuration. The acute conditions which occur in the course of influenza and some of the exanthemata are probably due to direct extension of the infection from the nose.

(C) BACTERIOLOGY

K. Goadby[2] in a series of fourteen cases found various forms of staphylococci and streptococci, viz. :—

Staphylococcus aureus—seven cases.
,, *albus*—eight cases.
,, *citreus*—one case.
,, *viscosus*—two cases.
Streptococcus brevis—eight cases.
,, *longus*—one case.

Of the other organisms identified, the *Bacillus fusiformis aerobius* was isolated twice, Friedländer's bacillus twice, and the *Saccharomyces neoformans* three times.

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[1] *Brit. Journ. Dent. Sci.*, May 15, 1895.

[2] *Brit. Med. Journ.*, August 22, 1908, p. 465.

In acute suppuration of influenzial origin pure cultures of the influenza bacillus may be found. Tilley[1] states that "As a general rule a mixed infection is present, in which the *Diplococcus pneumoniæ* is prominent, together with the *Staphylococcus pyogenes aureus* and *albus*, *Streptococcus pyogenes* and *Bacillus coli*."

(D) SIGNS AND SYMPTOMS

(*a*) **Acute.**—The most typical symptoms of suppuration of the sinus are seen after influenza. There is a feeling of intolerable distension of the zygomatic region, with pain of a throbbing character. The skin covering the bone becomes swollen, red, and very sensitive. Coughing and blowing the nose accentuate the feeling of distension by increasing the tension in the cavity. If the ostium maxillare is patent, there may be a discharge from the nose. The pain is most severe in cases where the opening is blocked, but it is at all times acute, as the inflammatory infiltration of the parts themselves produces pressure on the nerves. When the ostium is blocked an increased tension from pent-up discharge naturally increases the pain. General febrile symptoms are present.

(*b*) **Chronic.**—These cases are often extremely difficult to cure, and may escape recognition for a long time. The most prominent symptom is discharge from the nostril on the affected side. A bad odour is at times noticeable by the patient himself, unless his olfactory powers have been blunted by nasal disease. Pain is not often severe and is not necessarily local. The pain may be referred to the frontal region or to the teeth, or may be felt over the affected sinus. The part may be tender and the patient unable in consequence to sleep on the affected side. There is generally some thickening and capillary injection of the soft parts over the affected sinus. Should the ostium maxillare become blocked when the pus has filled the cavity and is exerting pressure, the symptoms become acute. It must be remembered that pus under pressure in the sinus behaves precisely in the same manner as pus under pressure elsewhere, i.e., it finds an exit by the path of least resistance. There is no bulging of the walls or displacement of eyeball or alveolar process. Many cases presenting symptoms which have hitherto been regarded as suppurating sinuses are really cases of suppurating cysts, mostly dental cysts.

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[1] "The Science and Practice of Dental Surgery," edited by Norman G. Bennett, p. 680.

(E) COMPLICATIONS

Suppuration in the maxillary sinus may lead to *necrosis* of its walls, to *infection of the sphenoidal sinuses*, or to *septic meningitis* through venous channels (deep facial and pterygoid plexus).

(F) DIAGNOSIS

In all cases of chronic suppuration there is some thickening of soft parts over the affected sinus; slight in many cases, but always noticeable. A purulent discharge from the nose, accompanied by a dull, deep-seated pain, is strongly suggestive of suppuration of the sinus. A diagnosis must be made from ozœna; in the latter, the breath is offensive to bystanders but not to the patient, while the reverse is the case in suppuration of the maxillary sinus. The presence of septic teeth in the molar or premolar region would assist in the diagnosis. Pain in the frontal region of one side (supra-orbital nerve) should always arouse suspicion of disease of that side; this pain is in some cases severe, even in the chronic types of suppuration.

The *presence of pus may be determined* by several methods:—

(*a*) Cleanse the nasal cavity, and place the patient in a position which brings the ostium lowest. If the ostium is patent, pus will trickle from the nostril. With a nasal speculum pus may be seen in the middle meatus.

(*b*) The *sinus may be punctured* by a trocar and cannula through the canine fossa or nose and washed out through the cannula so inserted.

(*c*) *Transillumination.*—Put the patient into a totally dark room and place an electric light in the mouth. Compare the two sides and note:—

(i) Whether the pupils are equally illuminated from within.

(ii) Whether the patient appreciates light equally on both sides (patients can usually answer the question intelligently).

(iii) The amount of light visible around the lower edges of the orbits.

(iv) The amount of light passing through the cheeks.

Conditions influencing Transillumination

Anatomical.—Transillumination is best seen in patients of spare build, whose palates and nasal fossæ are normal. The degree of transillumination is lessened in cases where the sinus is small; where bony partitions are present; and where the palate is high.

Pathological.—The general transillumination is increased when a cyst is present which has caused thinning and expansion of the bone, provided that the contents of the cyst are clear. Transillumination through the pupil is obstructed in certain morbid conditions of the eyes, while general transillumination is diminished when (1) the sinus contains pus, mucus, &c., (2) the lining membrane is thickened as the result of a chronic inflammatory process, (3) solid growths are present in the cavity itself or invading it from without.

Transillumination is not an infallible method of diagnosis, but in combination with other methods it is one of great value. Errors are likely to arise in consequence of the varying thickness of the walls of the cavity in the same individual and the presence of suppuration in both sinuses.[1]

Occasionally the signs of suppuration are obscure, as illustrated by the following case[2]:—

> "A female, aged about 55, very neurotic, complained of severe neuralgic pains of the left side of her face and head, of many years' standing—probably twenty at least. Her peculiar mental condition made it impossible to get a history or to trace any coherence in the distribution or occurrence of her pain. One point only stood out: that she always began her tale of woe by reference to the left maxilla. The mouth was edentulous and all that called for note was a slight fulness of the left maxillary tuberosity, as compared with the right. There was no tenderness observable. Examination of the nose and antral transillumination were negative; a radiograph showed no sign of teeth. No treatment improved her, and eventually it was decided to explore the left tuberosity, influenced by the slight fulness and persistent reference of pain to that part. On opening up, the crown of a molar tooth was met with and its extraction was followed by a gush of muco-pus from the antrum. The roots of the tooth were almost absorbed and the remains of the periodontal membrane engorged, showing that the surrounding bone was inflamed."

In this case tangible signs were practically absent, the only indications of trouble being the persistent neuralgia and the tenderness and fulness of the left maxillary tuberosity.

(G) TREATMENT

(*a*) **Acute.**—The treatment of suppuration in the maxillary sinus consists in giving free vent to the pus and thoroughly draining the cavity, as in the case of suppuration in other parts.

(i) If the cause is septic infection from a tooth, the tooth should be removed and the sinus perforated through the empty socket. The opening should be about a quarter of an inch in diameter; if made too narrow, considerable pain will be caused in inserting the nozzle of the syringe to irrigate the cavity. The instrument shown in fig. 906 will be found useful for perforating the bone. The passage should be kept patent by a vulcanite plug attached to a small denture. The cavity should be irrigated three times daily with about half a pint of normal saline solution or a weak solution of chloramine. With a lessening of the discharge of pus the irrigations may be reduced in number until the suppuration has ceased, but it is advisable that daily syringing should be continued for at least one week, the opening then being allowed to close. The irrigation is most conveniently carried out with a Higginson's enema syringe fitted with a suitable nozzle.

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[1] See useful paper on "Transillumination of the Antrum of Highmore," by A. Brown Kelly, *Brit. Med. Journ.*, March 25, 1905, p. 650.

[2] Recorded by J. G. Turner, *Gazette of the Royal Dental Hospital of London*, vol. i, p. 49.

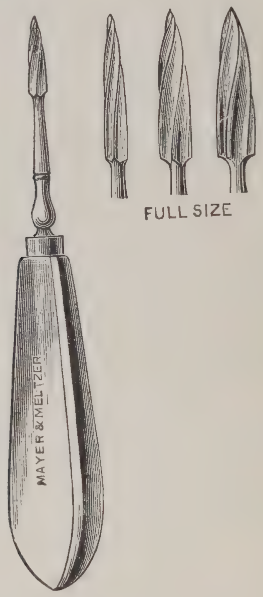

Fig. 906.[1]

(ii) If the cause is nasal in origin, the sinus should be drained through an opening in the inferior meatus.

(*b*) **Chronic.**—The symptoms are often deceptive, more especially when they arise from a nasal cause. There is a general consensus of opinion that the most satisfactory results are obtained by curetting the diseased mucous membrane and establishing intranasal drainage. For the technique of these operations the student should consult a work on "Diseases of the Nose."

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[1] For the use of this block I am indebted to Messrs. Mayer and Phelps.

Vaccine treatment has been used in cases which have not responded to drainage and lavage, but the results have not been satisfactory.

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CHAPTER XXXII

Tumours of the Jaws

Epulis — Fibroma — Chondroma — Osteoma — Myeloma — Adenoma — Angioma — Papilloma — Myxoma — Carcinoma — Sarcoma —Endothelioma.

It is proposed in this chapter to give a brief description of the more salient features of tumours of the jaws, with the object of assisting students to diagnose the swellings of the jaw which may come under their notice.

(A) Innocent Connective Tissue Tumours

(1) Epulis.—This clinical term is used to denote any solid swelling originating in relation with the alveolar process. An epulis usually springs from the tissues of the inter-proximal spaces; in the process of growth it tends to spread over the crowns of the teeth, and the surface of the growth may become ulcerated by friction against the teeth of the opposing jaw. An epulis may be situated in any part of the arch, but the most frequent site is the incisor region. It may spring from the margin of the alveolar process, or from the periodontal membrane, so that when the tooth is removed the growth comes away (figs. 907 and 908).

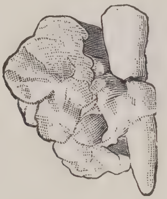

Fig. 907.—Mandibular canine with growth adherent to the periodontal membrane.

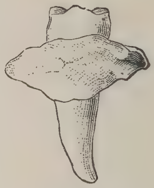

Fig. 908.—Mandibular premolar with growth adherent to the periodontal membrane.

In *structure* an epulis may consist of a mass of granulation tissue, showing in places a tendency to the formation of fibrous tissue. In other cases the growth may be composed of fibrous tissue more or less rich in connective tissue cells—round cells, fusiform cells and giant cells at times predominating (fig. 909). In the fibrous bundles there may be spaces with mucous tissue, or there may be a development of blood-vessels giving the growth the appearance of an angioma.

In cases where the giant cells predominate the growth usually presents a mulberry-like appearance and is usually known as a "myeloid" epulis, but it is not similar in character to the central myeloma seen in the jaws. "The giant cells lie in tissue composed of oval and round nuclei embedded in a distinctly fibrillar matrix, and there is a distinct tendency to fibrillation of the stroma, and in this fibrillation the giant cells take a distinct part."[1]

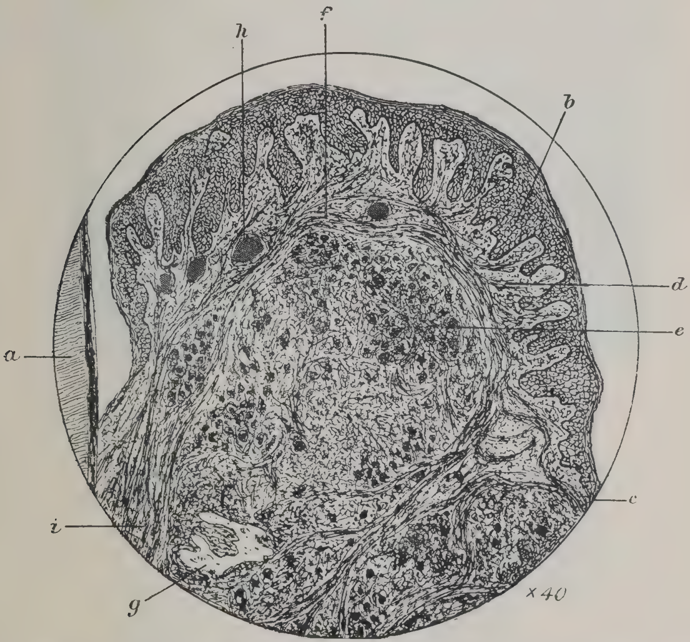

FIG. 909.—Longitudinal section of an epulis similar in external appearance to specimens figs. 907 and 908. *a*, dentine and cement; *b*, stratified epithelium; *c*, basement membrane; *d*, submucous tissue; *e*, masses of giant cells; *f*, fibrous septa; *g*, nodule of bone; *h*, spaces filled with colloid material; *i*, attachment of tumour to the cement. (From a drawing by A. Hopewell-Smith.)

Spicules of bone are often present in an epulis. Fatty changes may be a prominent feature (see fig. 910). The growth had arisen

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[1] See "The Pathology and Treatment of Tumours of the Jaw," by F. Eve, *Brit. Med. Journ.*, June 29, 1907, p. 1525.

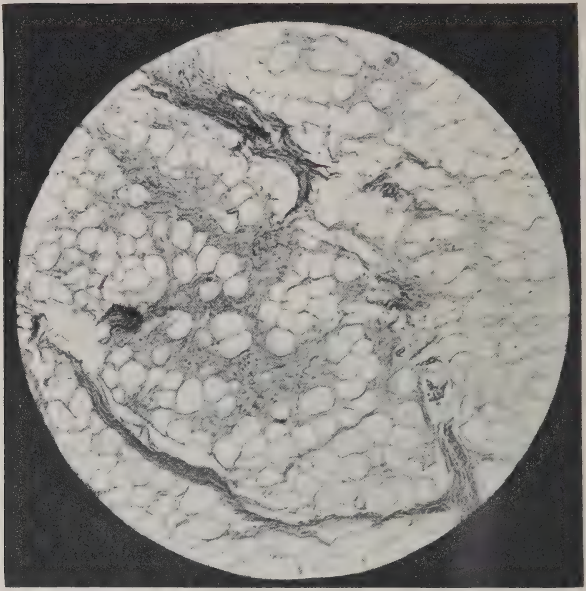
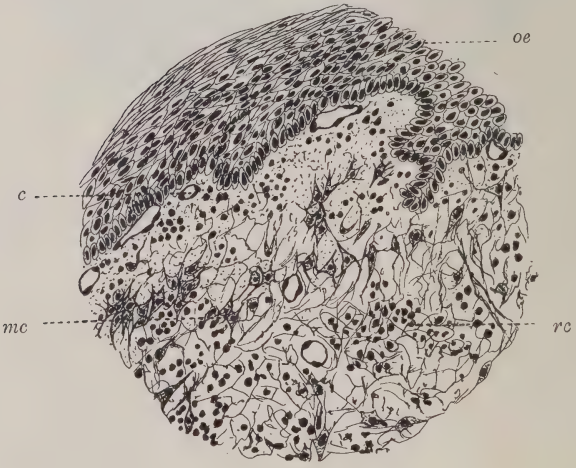


Fig. 910.
From *Brit. Dent. Journ.* Paper by D. L. Radford.



× 250.

Fig. 911.—"Epulis" containing myxomatous cells. *oe,* oral epithelium; *mc,* myxomatous cells; *rc,* round cells; *c,* capillary. (From a drawing by A. Hopewell-Smith.)

in connection with the roots of a mandibular molar and the upper surface, which was in contact with the maxillary teeth, was ulcerated. In a few specimens a development of myxomatous cells is seen (fig. 911).

An interesting feature of many of these growths is the presence of epithelium. This was first described by Malassez,[1] who considered that such growths had their origin in the more superficial epithelial "rests" which are so plentiful in the periodontal membrane. The primary growth starts in these epithelial masses, followed by a reaction in the surrounding mesoblastic tissue which tends to hold the epithelium in check. The following case, described by J. H. Mummery,[2] is of interest because it shows the presence of epithelium together with various degenerations and cell changes. The sections were prepared from a large epulis removed from the region of the mandibular incisors.

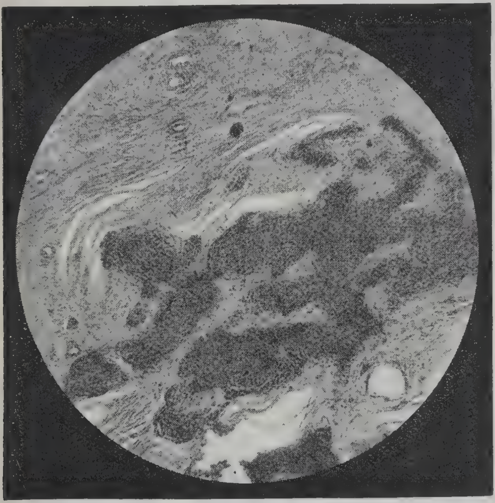


Fig. 912.
From *Brit. Dent. Journ.* Paper by J. H. Mummery.

"Immediately beneath the normal gingival epithelium covering the tumour, strands of connective tissue are seen forming a narrow zone parallel to the surface and showing the ordinary structure of a fibrous epulis; there is considerable cell infiltration immediately beneath the mucous membrane. Beneath this portion of the

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[1] *Archives de Physiologie,* Ser. iii, Tome v, 1885, pp. 309-335.

[2] *Brit. Dent. Journ.,* vol. xlii, p. 185.

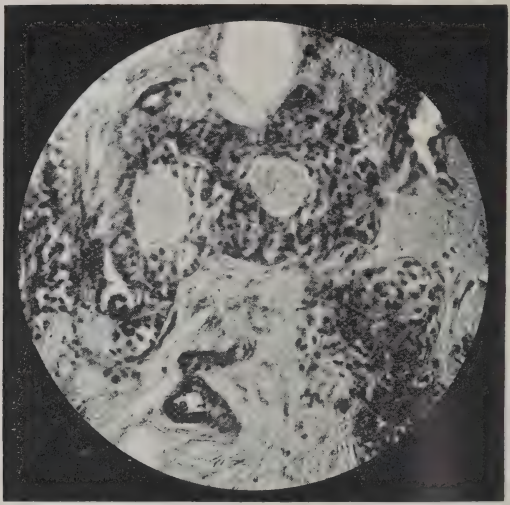

Fig 913
From *Brit. Dent. Journ.* Paper by J. H. Mummery.

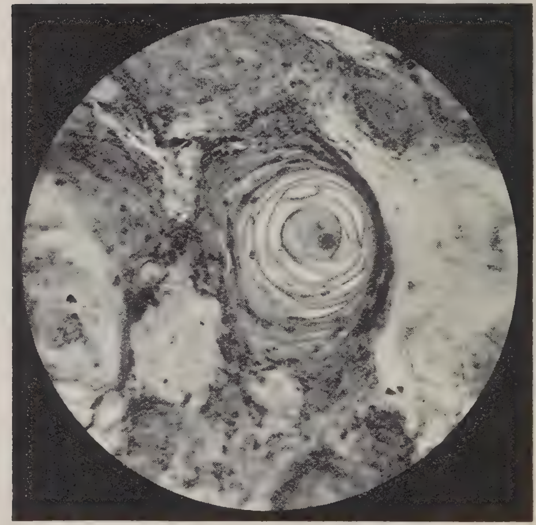

Fig. 914.
From *Brit. Dent. Journ.* Paper by J. H. Mummery.

growth in which the occurrence of low inflammatory changes would appear to be indicated by the granulation tissue, masses of epithelial cells have invaded the growth. These are not connected with the surface epithelium, and are probably derived from epithelial rests deeper in the tissues. Most of these epithelial masses are solid strands with no central lumen (fig. 912)."

"The connective tissue bundles pass between the epithelial masses, but they soon become indistinct, and further in are seen to have undergone colloid degeneration, their connective tissue origin being only recognizable by a faint fibrillation and some scattered fibroblasts (fig. 913). The bulk of the tumour is made up of epithelial cells and masses of colloid, many of the epithelial cells being of very large size and arranged in very definite and characteristic cell nests, as in epithelioma (fig. 914). Some of the epithelial bodies are calcified, and many capillaries are obliterated by calcific material in some parts of the growth. There are large accumulations of fatty material in other places."

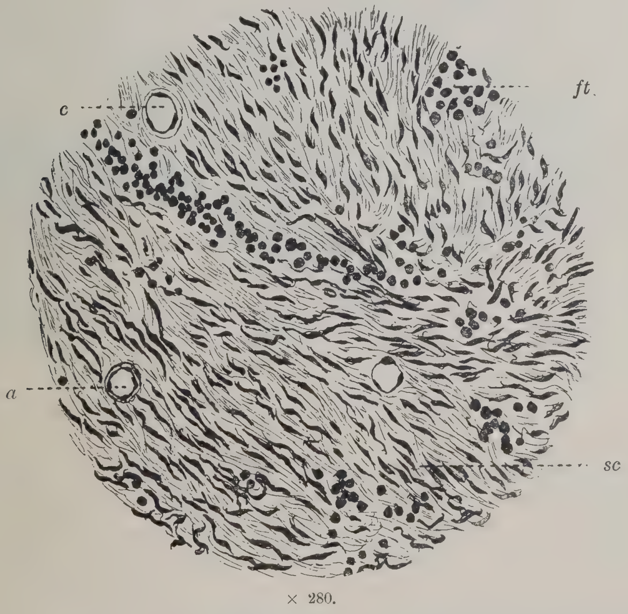

Fig. 915.—True fibroma of the gum. *sc,* spindle cells embedded in fine stroma of connective tissue fibres; *ft,* formative tissue composed of round cells; *c,* capillary; *a,* arteriole. (From a drawing by A. Hopewell-Smith.)

Treatment.—An epulis is invariably associated with septic teeth. The teeth which are in relation with the growth should be extracted, and when the wounds have healed the tumour can be removed, care being taken to cut away the attachment to the bone. When an epulis has been completely removed together with the offending teeth there appears to be no tendency for the growth to recur.

(2) Fibroma.—Tumours of the jaw composed of fibrous tissue may be either (*a*) periosteal or (*b*) endosteal.

(*a*) **Periosteal Fibroma.**—This type of growth must be clearly differentiated from the epulis. The true periosteal fibroma is composed of bundles of white fibrous tissue crossing one another in various directions and assuming a concentric arrangement in the periphery. It is usually pedunculated and of slow growth and may occur at any time from infancy up to adult life. The usual sites are in the mid-line of the mandible and in the premaxilla. In the mid-line of the mandible they may arise from some embryonic tissue or " rests " left at the time of fusion of Meckel's cartilage; in the premaxillary region they may be due to overgrowth along the sutures between the premaxilla and maxilla.

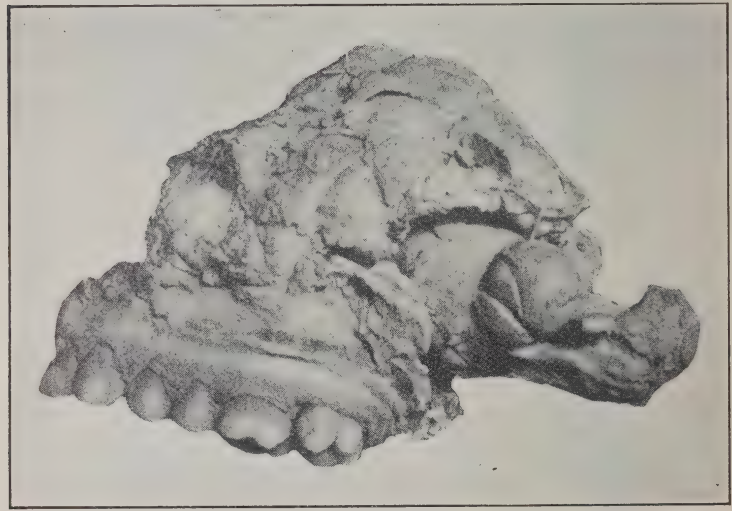

Fig. 916.—Fibroma of the maxilla arising in the maxillary sinus. (Museum of Charing Cross Hospital.)

The microscopical anatomy of a true fibroma of the gum is shown in fig. 915.

Fibromata show at times a tendency to degenerative changes. In a growth examined for me by J. H. Mummery there were wide intervals between the bundles of fibrous tissue filled with large plasma cells, and in some parts of the growth the connective tissue fibres were entirely replaced by these cells. The epithelium covering the growth was invaded by masses of polymorphonuclear leucocytes, which were rapidly destroying the epithelial cells between and within which they had penetrated.

(*b*) **Endosteal Fibroma.**—When this growth occurs in the maxilla, it is said to spring from the periosteum of the maxillary sinus. It usually develops slowly and causes a gradual enlargement of the walls by pressure upon the thinner and more readily deformed boundaries—viz., the facial, orbital and nasal walls (fig. 916). In the mandible the endosteal fibroma causes a gradual expansion of the body of the jaw, and both the external and internal plate walls usually give way. The outline of the swelling is fairly regular.

Considerable interest centres round the origin of the endosteal fibroma of the mandible. J. H. Targett[1] gives an account of a small fibrous growth which was removed from the mandible of a boy aged 9. At the age of 7 he had sustained a blow on the chin, and six months afterwards a small swelling which steadily increased was noticed in the jaw. On removing the swelling the mandibular nerve was found to pass through the middle of the tumour, the fibrous growth completely surrounding it. Targett is inclined to think that this and other cases of central fibromata of the jaw may originate in the sheath of the mandibular nerve.

It is possible that many of the cases recorded as endosteal fibromata belong to the category of fibrous odontomes. As an example we may quote the following case.[2] A female child, aged eight, presented an ovoid, elongated, smooth, hard and painless swelling of the right side of the mandible. The swelling extended forwards to within 1 in. of the symphysis and backwards beyond the angle of the jaw. The outer plate of the bone was principally bulged, the inner surface being but little altered. The soft parts over the tumour were quite normal, and the teeth behind the canine were missing. On removing the outer plate of bone, the tumour was found to be lying loosely between the plates of the jaw, and was shelled out with little difficulty, being held only at the lower and hinder part where it lay over a permanent molar tooth. This tooth was removed along with the tumour and was found to be attached to the tumour by a thin membrane. A careful examination showed that this delicate fibrous membrane passed from the outer surface of the tooth root to the delicate connective tissue capsule of the tumour.

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[1] "The Pathology of Certain Growths about the Lower Jaw," *Trans. Odonto. Soc.*, vol. xxxiv, p. 215.

[2] Recorded by Jordan Lloyd, *Journ. Brit. Dent. Assoc.*, August, 1898, p 563.

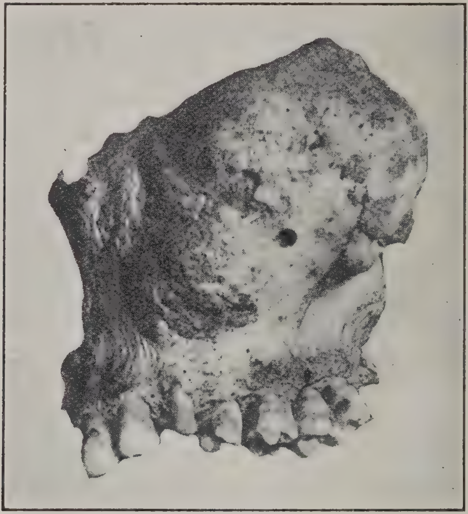

Fig. 917.—Osteoma of the maxilla. (Museum of Charing Cross Hospital.)

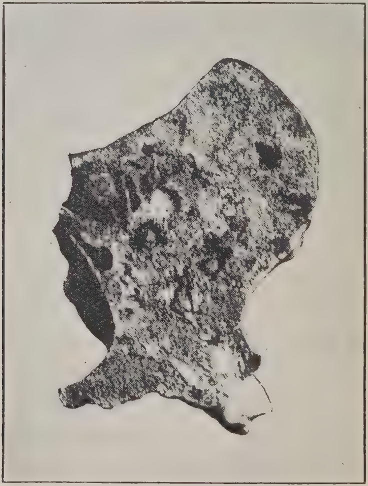

Fig. 918.—Section through tumour shown in fig. 917.

(3) Chondroma.—Tumours composed of cartilage rarely occur in the jaw. In the maxilla, according to Heath, " The disease appears as a rule early in life, springing from the surface of the bone or from the antrum, and then making steady progress either externally or internally. The tumour produces absorption of the bone of the maxilla in its progress, and protrudes beneath the skin, which, however, it rarely involves."

In the mandible a chondroma may be endosteal or periosteal. The former type causes a gradual distension of the body of the bone somewhat similar to an endosteal fibroma; the latter type may grow to an enormous size, a specimen recorded by Heath weighing 3½ lb. There is reason to believe that some of the cases recorded as chondromata are of a sarcomatous nature.

(4) Osteoma.—Tumours composed of bone form a most interesting group of jaw tumours. They may be circumscribed or diffuse. They may be composed of cancellous or compact bone.

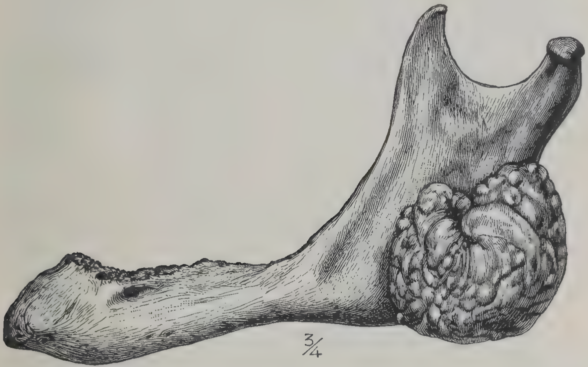

FIG. 919.[1]—A circumscribed osteoma growing from the angle of the mandible. (Bland-Sutton.)

In the maxilla the whole bone may be affected. An excellent example is shown in figs. 917 and 918.[2] The jaw is expanded generally, but more especially the facial surface. The outer compact plate is smooth except near the infra-orbital foramen, where the cancellous structure forming the tumour appears. Hancock, who removed this growth, refers to the fact that the bone "yielded to pressure to such an extent as to lead to some doubt as to its osseous nature."

Tumours composed of compact bone and of an ivory consistency have been recorded as occurring in the maxillary sinus. It is possible that many of these are really examples of odontomes.

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[1] From "Tumours, Innocent and Malignant," by J. Bland-Sutton.

[2] From the Museum of Charing Cross Hospital.

Circumscribed osteomata growing from the facial aspect of the maxillæ are often symmetrical.

In the mandible the tumour formed of compact bone is the most common, but, occasionally, the cancellous variety occurs. Osseous growths of the mandible are sessile in the majority of cases. The commonest situation is the inner aspect of the alveolar process covering the premolar teeth. Other likely situations are the angle of the jaw (fig. 919) and the region of the mental foramen. The whole thickness of the bone may be affected, but such conditions are extremely rare.

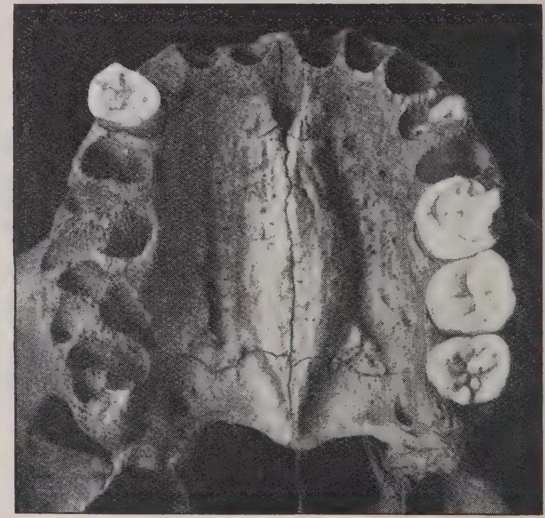

Fig. 920.[1]

Torus Palatinus.—This name is given to a thickening of the bone in the mid-line of the palate, which clinically simulates an osseous growth. The condition assumes various forms; in some cases the thickening extends almost the entire length of the palate and is symmetrical, as shown in fig. 920; at other times, it is asymmetrical; while other examples may present the appearance shown in fig. 921. It may be present in children. Sections of bones showing the torus palatinus are given in figs. 922 and 923.

Näcke[2] states that he examined 1,449 individuals, of whom

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[1] Figs. 920 to 923 are from a paper on the torus palatinus by Rickman Godlee, *Proc. Roy. Soc. Med.*

[2] *Neurol. Centralbl.*, June 15, 1893.

22 per cent. showed this deformity. He states that it is most commonly met with amongst the insane and criminals.

(5) Myeloma.—" A myeloma is a tumour composed of tissue identical in structure with the red marrow of long bones " (Bland-Sutton). The naked-eye appearance is characteristic—it is a maroon or dark red colour (fig. 924). Microscopical sections show them to be composed of spindle and round cells, with numerous giant cells more or less uniformly interspersed (fig. 925). The giant cells vary in number and shape and in the number of their nuclei. They may show vacuolation and fatty degeneration. They are

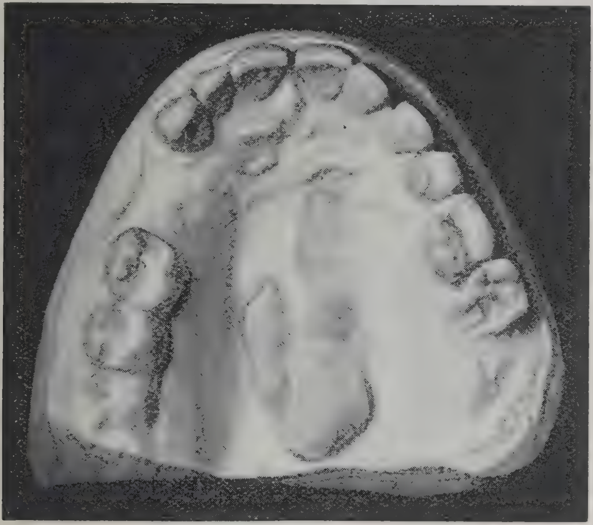

Fig. 921.

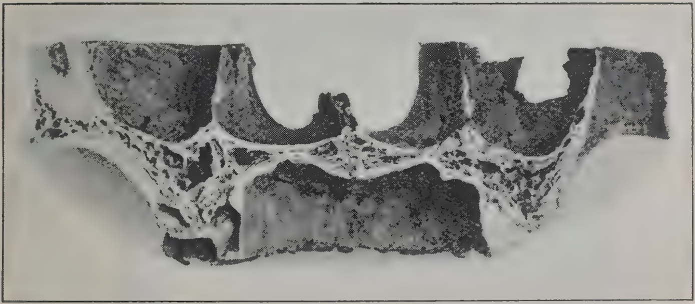

Fig. 922.—Section of fig. 920; the lower table as well as the diploe is thickened.

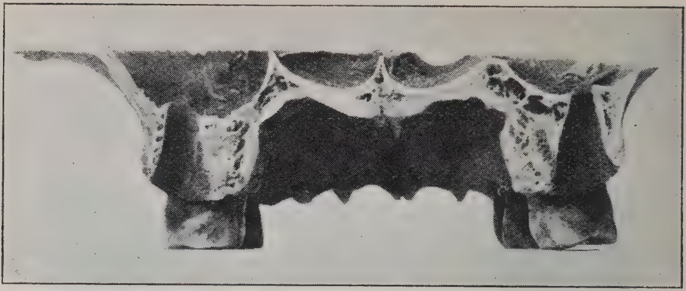

FIG. 923.—Section of torus caused by thickening of the diploe.

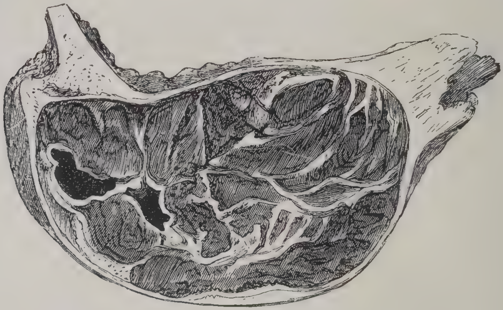

FIG. 924.[1]—Myeloma of the mandible. (Heath.)

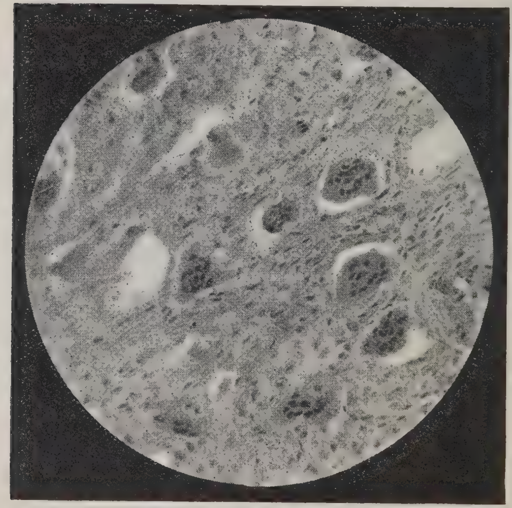

FIG. 925.—Myeloma. Giant cells and small spindle cells. × 120. From *Brit. Dent. Journ.* Paper by J. H. Mummery.

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[1] From "Injuries and Diseases of the Jaw," by Christopher Heath.

always endosteal in origin, and if completely removed there is no sign of recurrence. They do not invade glands, nor disseminate by the blood-stream. Hence some writers place them in a class separate from sarcomata, under the name of myelomata.

In the maxilla, myelomata arise in the alveolar portion of the bone, or in the facial wall of the maxillary sinus near its junction with the alveolar process. In the mandible they arise in the body of the bone below the level of the teeth in the alveolar process. In both jaws the favourite situation is the region of the second premolar and first molar. They may arise in the premaxilla, or even in the hard palate.

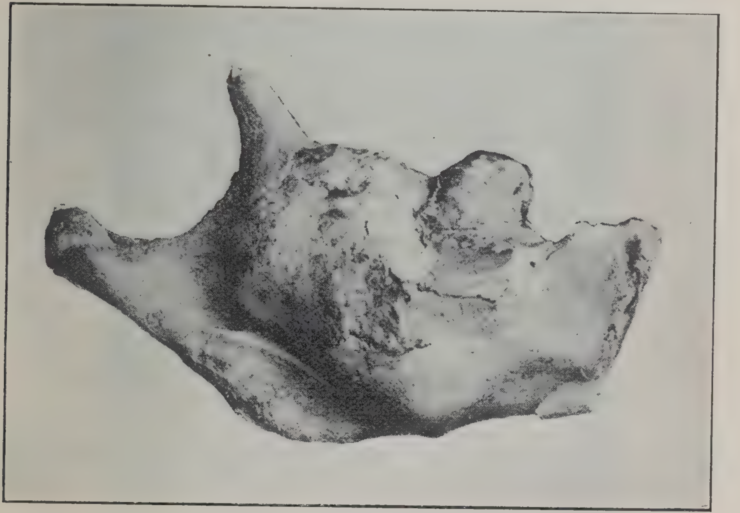

FIG. 926.—Myeloma of the mandible. (Museum of Charing Cross Hospital.)

In some cases there is a history of the growth starting in connection with an unerupted tooth. In one example a child twelve years of age developed a growth around an unerupted maxillary canine. The growth had caused an expansion of both walls of the maxilla and was extruding through the socket of the deciduous canine.

There is reason to believe that myelomata may be started by sepsis. In three patients which have come under observation there was an extreme degree of dental sepsis, and the growth had arisen in connection with the roots of septic teeth.

Myelomata grow in a way somewhat similar to cysts. They tend to keep a more or less spherical shape and to bulge the walls which present the least resistance. The growth frequently makes its way to the surface viâ a tooth socket, and may be mistaken for a simple epulis. In the maxilla the growth may bulge into the maxillary sinus without invading the walls. In the mandible these growths give rise to painless swellings and tend to deform and, finally, in part destroy the outer plate long before the inner (fig. 926). When the swelling projects into the buccal cavity, its outline is not globular, as with a cyst, but presents slight undulations; it is solid and non-fluctuating.

In fig. 927 is shown the radiogram of a myeloma growing in the region of the mandibular right first molar. There was a history, six years before, of a difficult extraction, and the patient was unaware of any swelling in the jaw. This growth clinically simulated a dental cyst.

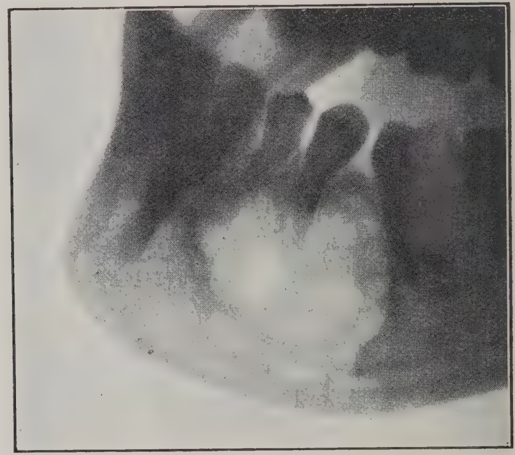

Fig. 927.

(6) Adenoma.—This form of tumour may arise in the soft palate or in the mucous membrane of the hard palate. Adenomata are firm, slow-growing tumours which, on removal, shell out easily, but there are many departures from the typical adenoma, and at times it is almost impossible to distinguish between the adenomata and the carcinomata.

There seems to be a tendency for some adenomata to become malignant. The following case[1] is instructive from the clinical aspect. " A female, aged 37, noticed a growth about the size of an almond freely movable under the mucous membrane of the hard palate. There was considerable lancinating pain in the tumour, and some carious teeth on that side of the mouth were removed, as they were considered to be the cause of the swelling. There was a discharge of pus from the socket, and the swelling in the palate diminished in size but did not disappear. Three years subsequently the growth was incised, the dimensions of the swelling then being an inch by half an inch. Ulceration followed, and the growth was then freely removed. Microscopic examination showed that it was an adenoma of the palate which had become malignant and infiltrating."

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[1] See *Brit. Dent. Journ.*, vol. xvii, p. 181.

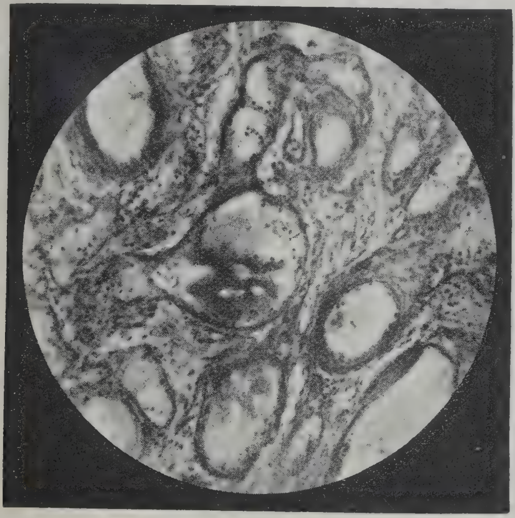

FIG. 928.—Angioma. From a growth on the gum. × 120. From *Brit. Dent. Journ.* Paper by J. H. Mummery.

(7) Angioma.—These tumours, which occasionally occur upon the gums, may simulate a capillary nævus, in which case they are composed of dilated capillaries; a venous nævus is simulated when the tumours are composed of irregular spaces containing venous blood; and an arterial nævus, when the irregular spaces are filled with arterial blood. The microscopical appearances of an angioma are shown in fig. 928.

These growths usually present a smooth surface. They vary in colour, being bright red in arterial and purple in venous nævi; on pressure being applied they become pale, rapidly returning to their original condition after removal of the pressure. They are more common in the incisor region, though they may occur in the region of the molars. Starting as a little red spot, they gradually spread between the teeth and extend principally along the margin of the gum, both in front and behind the teeth. These growths bleed freely when touched with the tooth-brush, and in one case under notice the hæmorrhage was severe. In the case of distinct venous nævi, the tumour may attain to a large size and involve the mucous membrane of the gum, cheek and lip.

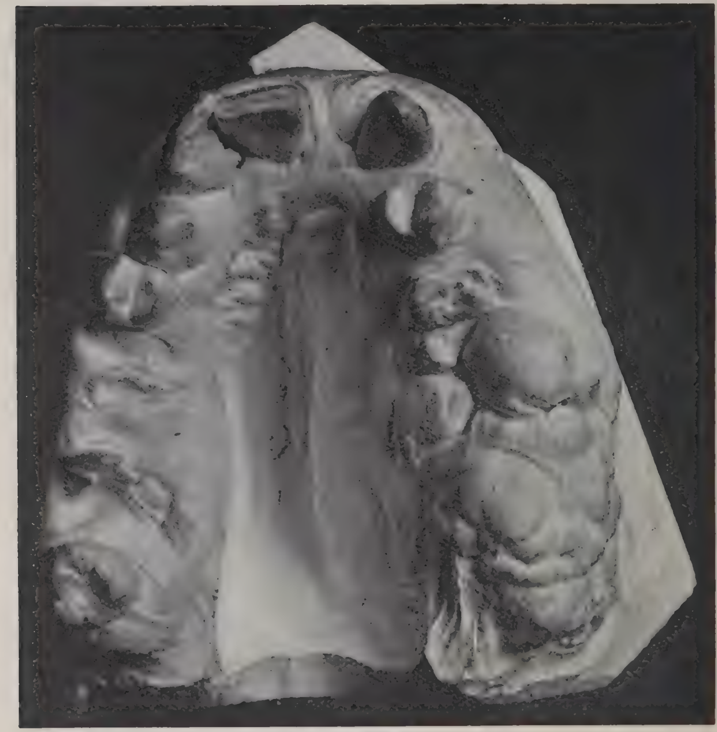

Fig. 929.
From *Brit. Dent. Journ.* Paper by H. Chapman.

In a case (figs. 929 and 930) recorded by H. Chapman[1] an angioma covered the area corresponding to the distribution of the second division of the fifth nerve. "From the right incisor to the remains of the first molar the tumour presented a smooth, venous-coloured surface; distally to the latter tooth the colour was lighter, and the surface resembled a cauliflower in appearance. In this region two or three lobulated masses of nævoid tissue were present."

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[1] *Brit. Dent. Journ.*, May 15, 1915.

Arterial angiomata are rare on the palate. A case is reported by Treves[1] of a small angioma about the size of a cherry situated between the two maxillary right incisor teeth. The angioma grew from the periodontal membrane and came away with the second incisor.

(8) Papilloma.—Two varieties are met with, the pedunculated and the sessile. The pedunculated are delicate polypoid growths and are always attached to the soft palate. The sessile or warty papillomata may be found in the muco-periosteum of the alveolar process or hard palate (see figs. 931 and 932).

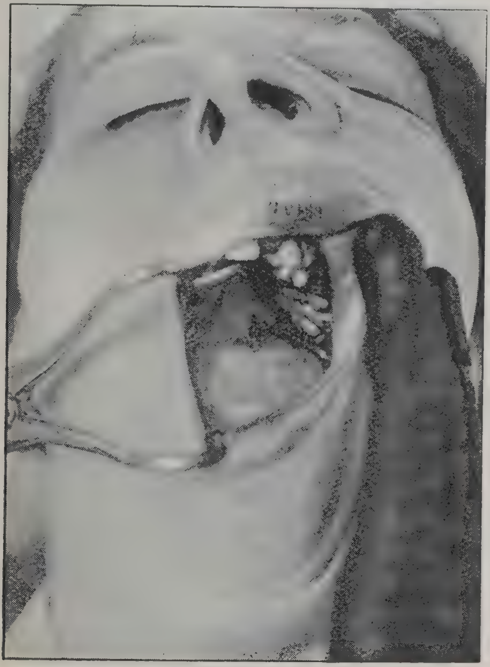

Fig. 930.
From *Brit. Dent. Journ.* Paper by H. Chapman.

They vary in size and may be no larger than a millet seed, or the growth may cover the greater part of half the hard palate.[2]

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[1] *Journ. Brit. Dent. Assoc.*, vol. ix, p. 252.

[2] See "Papilloma of the Oral Cavity," by J. Arkovy, *Trans. Odonto. Soc.*, vol. xiii, p. 16.

(9) Myxoma.—Pure myxomata are rare. A case of this type was reported by W. Daniels.[1] The patient, a woman, aged 27, noticed a hard lump on the side of the mandible near the premolars nine months before coming under observation. The tumour was uniformly firm and hard; there was no fluctuation and no obvious

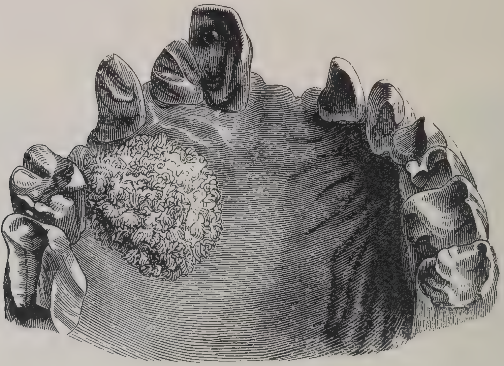
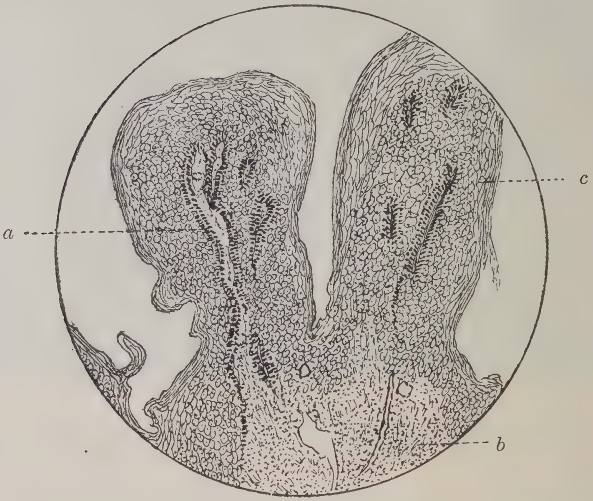


FIG. 931.[2]—Papilloma of the gum. (Heath.)



× 45.

FIG. 932.—Papilloma of gum. (From a drawing by A. Hopewell-Smith.) *a*, oral epithelium (stratified); *b*, submucous tissue; *c*, rete Malpighii.

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[1] *Lancet*, December 12, 1908, p. 1747.

[2] From "Injuries and Diseases of the Jaw," by Christopher Heath.

swelling in the cheek. The tumour was readily shelled out, leaving a cavity in the bone extending through to the inner plate. The tumour was a pure myxoma.

(B) Malignant Epithelial Tumours

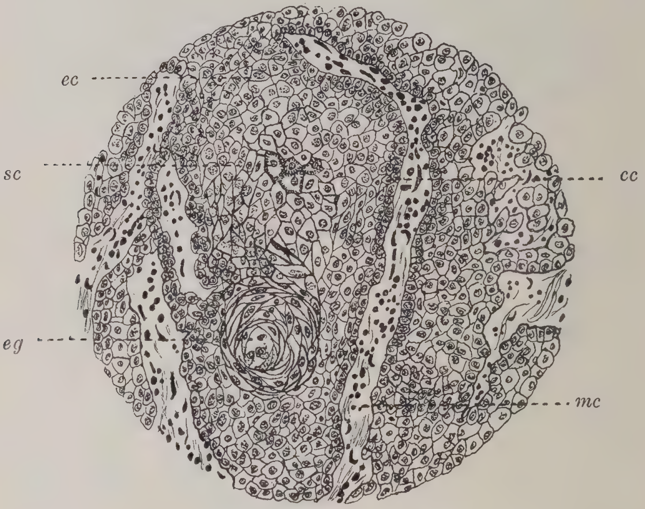
Carcinoma

"The essential character of a cancerous growth consists in an unlimited multiplication of the epithelial elements of the organ attacked. In some cases this may result in the formation of a superficial outgrowth of a papillomatous type, while deep processes or columns of cells advance into the tissues along the lymphatic channels, and even burst through the basement membrane of glandular alveoli. The irritation of this development leads to an infiltration of the surrounding structures with round cells, which are presumably inflammatory in origin, by the agency of which the normal tissues are disintegrated and removed, and a stroma of variable density develops around the epithelial outgrowths. Hence all cancerous tumours may be said to consist of a fibro-cellular or fibro-cicatricial stroma within the alveoli of which are collections of epithelial cells, sometimes arranged in a methodical manner, but more often packed irregularly together and with no intracellular tissue between them. The alveolar spaces are in reality dilated lymphatics, and hence it is easy to understand that carcinomata are disseminated along these vessels; the cancer cells are epithelial in origin, and of very variable size and shape; but they always retain more or less the character of the epithelium from which they are originally developed, so that, e.g., a squamous epithelioma is never derived from a part covered with columnar epithelium, or *vice versa*. Blood-vessels ramify through the stroma, and are more or less abundant according to its density" (Rose and Carless).

Histologically, cancer consists of connective tissue containing alveolar spaces filled with epithelium varying in size, shape and arrangement. The alveolar spaces communicate with one another so that the growth of the epithelium is continuous. The connective tissue structure between the individual cells seen in sarcomata does not exist in carcinomata.

(1) Maxilla

(*a*) **Squamous-celled Carcinoma (Epithelioma).**—This tumour always arises from the epithelium adjacent to the maxilla and, secondarily, invades the bone. A common starting point is the margin of the gum, generally the outer aspect, adjacent to a tooth which has been the seat of long-continued sepsis. In such a case the chronic sepsis from the tooth seems to have determined the growth of the carcinoma. This tumour may originate in the hard palate, and in such cases it can occasionally be traced to the chronic irritation of a badly fitting denture. The disease may also commence in the soft palate, the pillars of the fauces, the tonsil, and the buccal mucous membrane, and thence spread to the jaw-bone. It is possible that the irritation of the discharge from a chronic ulcer, primarily syphilitic in character, may cause a malignant growth of the adjacent epithelium; but this condition, though a comparatively common sequence in the case of the tongue, is very rare in the maxilla, since chronic syphilitic lesions are uncommon in the mucosa covering it.



× 300.

FIG. 933.—Squamous-celled carcinoma of the palate. *ec,* epithelial cells; *mc,* mesoblastic cells of submucous tissue; *eg,* epidermic globule of concentrically stratified epithelial cells; *ccc,* cylindrical cancer cells; *sc,* four "spiny" cells. (From a drawing by A. Hopewell-Smith.)

The squamous-celled carcinoma clinically may at first become evident as an ulcer. There is little doubt that in many of these cases a simple ulcer is present for some time in association with sepsis before malignant change occurs. If, after the removal of all sources of irritation, the ulcer does not rapidly heal, it should be viewed with grave suspicion and immediately submitted to microscopy (fig. 933). In other cases the earliest sign of the disease may be a nodule in the mucous membrane, or a papillary excrescence. But in whatever way it starts, an ulcer with more or less characteristic qualities soon appears. Its edge is hard, raised and tends to grow luxuriantly over the surrounding tissue, or, as is commonly said, is "everted." The surrounding tissues of the base are infiltrated; the floor is irregular, and may show irregular warty prominences and deep excavations at the bottom of which the bone may be exposed The discharge from the ulcer abounds in cancer-cells. A characteristic feature is the extremely fœtid odour emitted from the growth. The ulcer spreads rapidly until a large tract of the jaw may be involved. Cervical glands are early enlarged, mainly by malignant deposits and to a lesser degree by chronic sepsis.

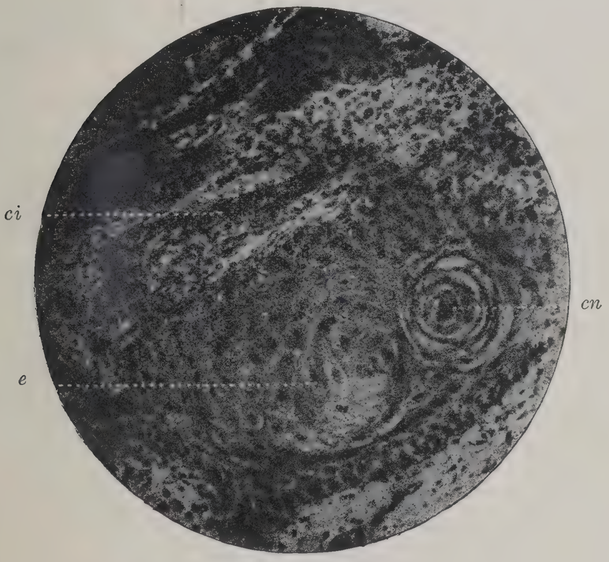


Fig. 934.[1]—*cn*, cell-nest; *ci*, small-celled infiltration of the tissues; *e*, islands of epithelial cells.

A curious form of squamous-celled carcinoma occurs in the maxilla, to which the name "boring epithelioma" has been given. As the name implies, this type of cancer tends to burrow into the substance of the jaw-bone or even into the sinus, showing from the surface very little, if any, evidence of its grave nature. The onset of this disease is insidious, and the symptoms very indefinite. It often appears to originate in chronic sepsis, as the following case shows: A patient,[1] a female aged 35, had had suppuration in connection with a maxillary left second incisor for a period of two years. The alveolar process retained its natural contour; there was no swelling or redness, but about half to three-quarters of an inch above the neck of the tooth there was a sinus, the edge of which was not swollen but was covered with sodden epithelium. The tooth was loose and a little tender, and, on pressing the parts, a small quantity of thickish pus was discharged through the sinus. The tooth was removed with a little difficulty, and adherent to it were ragged masses of tissue. On examination these proved to be carcinomatous in character (fig. 934). At the operation the growth extended from the right first incisor to the left first molar, and had only invaded the alveolar portion of the bone.

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[1] From "Histology and Patho-histology of the Teeth," by A. Hopewell-Smith.

(β) **Columnar-celled Carcinoma.**—This arises from the epithelium which lines the maxillary sinus and the growth is primarily in that cavity. The growth tends to fill the cavity completely, and finally erode one or more of its walls and invade the adjacent soft tissues. When confined to the cavity, the symptoms are very indefinite and are generally those of a persistent and intractable neuralgia. At an early period, if the maxillary sinus were transilluminated from the mouth, opacity might suggest the cause of the neuralgia. Generally speaking, the symptoms are in abeyance until the cavity is filled with the growth and pressure is exerted upon one of its walls. The growth may merely press upon the walls of the cavity and cause distension, or may erode through the boundaries of the cavity and infiltrate the soft tissues. For instance, the orbital plate may be pushed up, and perhaps some limitation of the movements of the globe of the eye may be seen; the facial surface may be encroached upon and a prominence of the cheek occur, with or without infiltration of the soft parts; or, should the posterior wall of the cavity be affected, a swelling may appear in the temporal region of the head above the malar arch. Inspection through the anterior nares may show a bulging of the inner wall of the maxillary sinus, or even a fungation of the growth into the nasal cavity. The teeth on the affected side may loosen and fall out, the sockets becoming filled with the growth. The cervical glands will sooner or later become enlarged.

Eve maintains that many of the growths of this type have their origin from "rests" of the germinal epithelium of the teeth. (See chapter on Odontomes, p. 631).

(γ) **Spheroidal-celled Carcinoma.**—This may originate from the epithelium of the glands of the mucous membrane of the maxillary sinus. The growth exhibits the same clinical characters as the columnar-celled neoplasm of the maxillary sinus (fig. 935).

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[1] *Trans. Odonto. Soc.*, vol. xxxiii, p. 231.

(2) Mandible

(*a*) **Squamous-celled Carcinoma.**—As in the maxilla, the growth arises from the adjacent epithelium, and, secondarily, invades the bone. It may originate at the gum margin, when chronic sepsis appears to play an important part in its causation; or it may commence in the floor of the mouth, the tongue, or the buccal mucous membrane, or the jaw may be secondarily invaded from the lower lip. At times the growth is due to irritation from an ill-fitting denture.

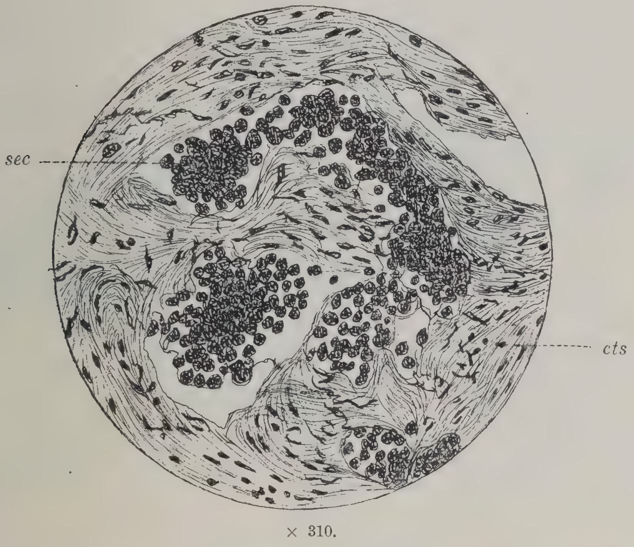

Fig. 935.—Spheroidal-celled carcinoma. *sec*, spheroidal cells; *cts*, connective tissue stroma. (From a drawing by A. Hopewell-Smith.)

A squamous-celled carcinoma arising in the anterior extremity of the sublingual sulcus (sublingual carcinoma) is of importance to the dental surgeon, as the ulceration may be mistaken for a simple ulcer arising from the irritation of a denture. The disease starts as a small nodule, or warty ulceration, in the floor of the mouth; ulceration follows and the disease spreads rapidly between the root of the tongue and the concave surface of the arch of the mandible. The surrounding tissues are speedily infiltrated; the tongue becomes fixed and the salivary ducts obstructed by pressure, or laid open by ulceration.

(*β*) **Columnar-celled Carcinoma** is very rare in the mandible. In all probability it originates in the "enamel organ rests" of the periodontal membrane. The growth causes an enlargement of the mandible before ulcerating into the cavity of the mouth.

The early recognition and treatment of carcinoma are most important, and, as the condition may come under the notice of dental practitioners in its early stages, its clinical signs should be thoroughly understood by them. All patients over 30 with ulceration of recent origin should receive close scrutiny. The following is a typical history. A. B., aged 55, stated that two teeth in the maxillary left molar region became loose and fell out, and that he had since been troubled with a nasty taste in the mouth. An examination of the teeth sockets showed them to be filled with a carcinomatous mass. On another occasion, a man, aged 47, complained of pain in the maxillary left molar region. He had received a blow in this region eighteen years previously, and the first and second molars had recently loosened and fallen out. The wound was filled with a mass of unhealthy-looking tissue; necrosed bone could be detected, and there was a profuse fœtid discharge. The patient had acquired syphilis twenty-five years previously. In this case, although the history was suggestive of a gummatous infil-

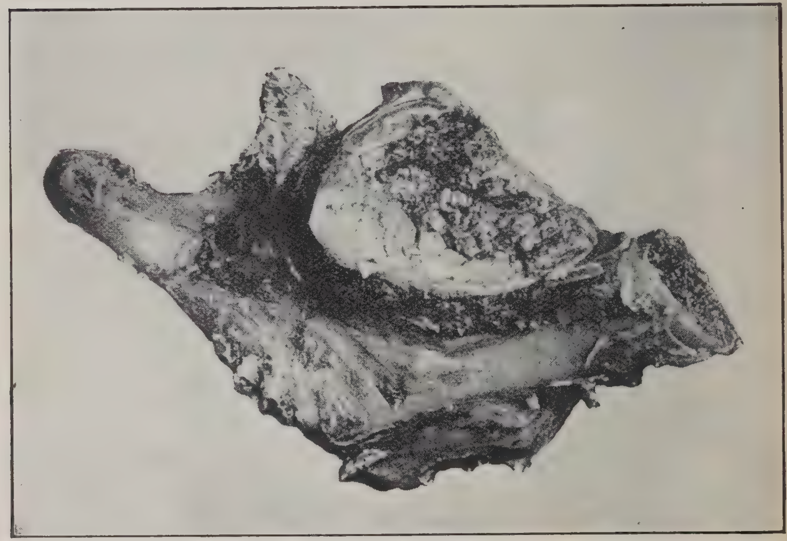

Fig. 936.—Squamous-celled carcinoma of the mandible. (Museum of Charing Cross Hospital.)

tration of the bone, the possibility of carcinoma could not be neglected. Microscopical examination showed merely granulation tissue. Under antisyphilitic treatment and local irrigation the condition cleared up.

(C) Malignant Connective Tissue Tumours

Sarcoma

The term **sarcoma** is used to designate a tumour composed mainly of embryonic connective tissue cells. A sarcoma usually presents a homogeneous appearance, the colour varies and depends to some extent upon the vascularity of the growth. Sarcomata vary in their malignancy. Locally this group of tumours spreads by infiltrating the surrounding tissue, and eventually replacing it. A general dissemination throughout the body is brought about by the vascular system.

Histologically a sarcoma is composed solely of one type of cell, yet the type varies in size and shape; for example, the cells may be classed as large or small, round, spindle, oval. They are held together by a delicate reticulum, which, with suitable preparation, can always be demonstrated between the individual cells. The blood-vessels track between the cells and are lined with a delicate endothelium. This peculiar arrangement of the vascular supply accounts for the extreme liability of sarcomata to hæmorrhage.

Patients suffering from sarcomata of the jaws are usually young —probably 40 per cent. of them are under 20 years of age. As in cancer, it is possible that chronic irritation plays an important part in their etiology. A definite history of previous trouble from the teeth can at times be obtained, and it is possible that in the past the relation of septic teeth to this type of malignant growth has been overlooked.

The round-celled, spindle-celled, fibro- and mixed-celled sarcomata are met with in about equal numbers. Rare types are the embryo-plastic odontome, the melanotic, the chondro, the myxo, the osteo, and alveolar varieties.

Round-celled, spindle-celled, mixed-celled, and fibro-sarcomata may arise, either as periosteal or, more rarely, endosteal growths. These tumours may occasionally arise after injury; for example, J. G. Turner[1] records a case where a man received a blow in the front of the mouth, which drove some septic incisors into the bone. Within a very short time he died of a small, round-celled sarcoma,

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[1] *Trans. Odonto. Soc.*, vol. xxxix, p. 112.

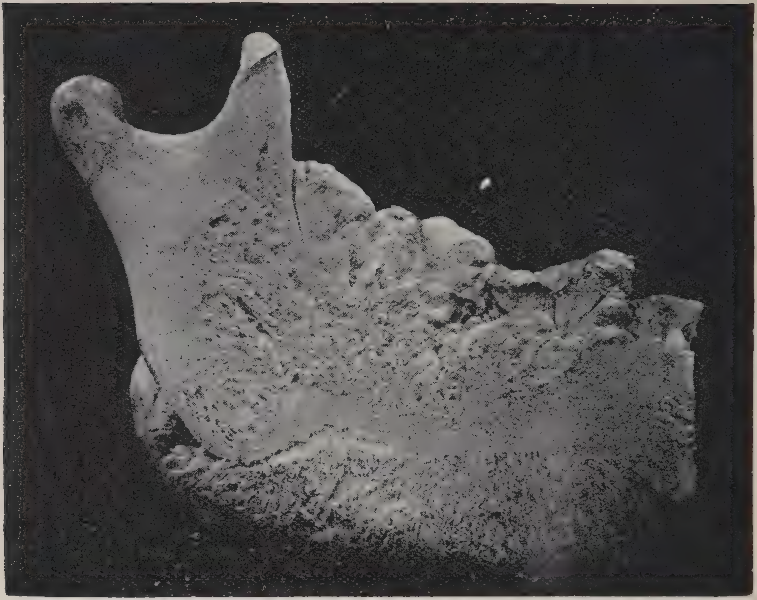

FIG. 937.[1]—A periosteal sarcoma. (Targett.)

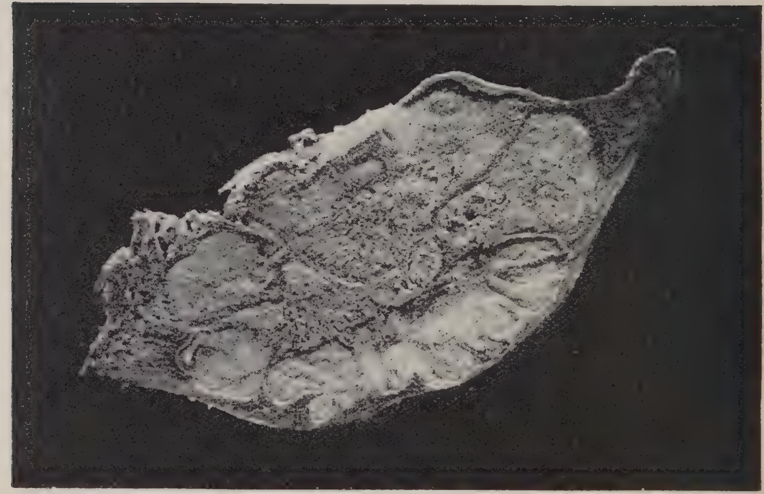

FIG. 938.[1]—An endosteal sarcoma. (Targett.)

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[1] From *Trans. Odonto. Soc.*

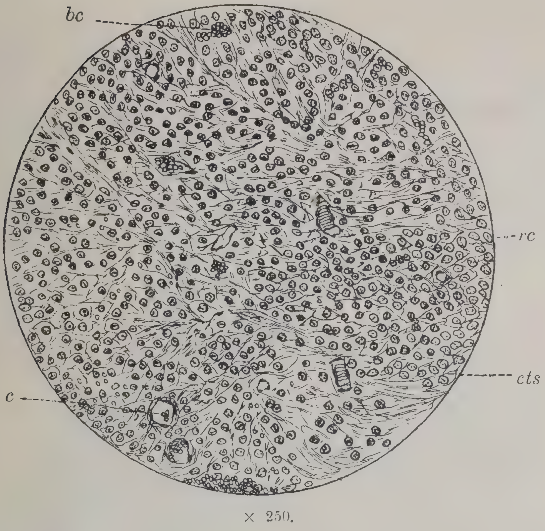


Fig. 939.—Round-celled sarcoma. *rc,* round cells; *cts,* connective tissue stroma; *bc,* blood corpuscles; *c,* capillary. (From a drawing by A. Hopewell-Smith.)

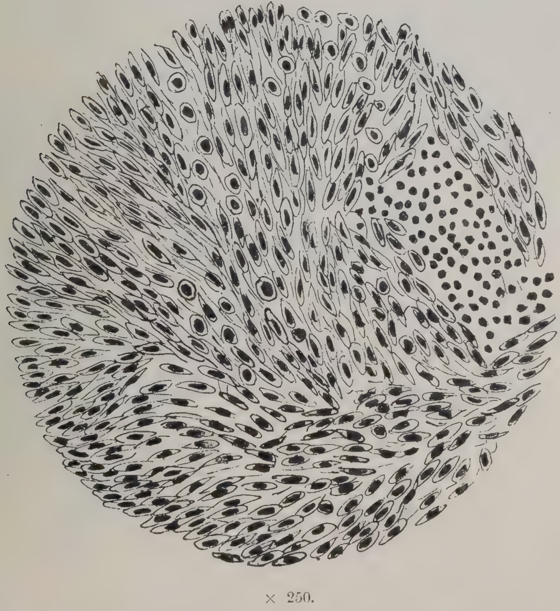
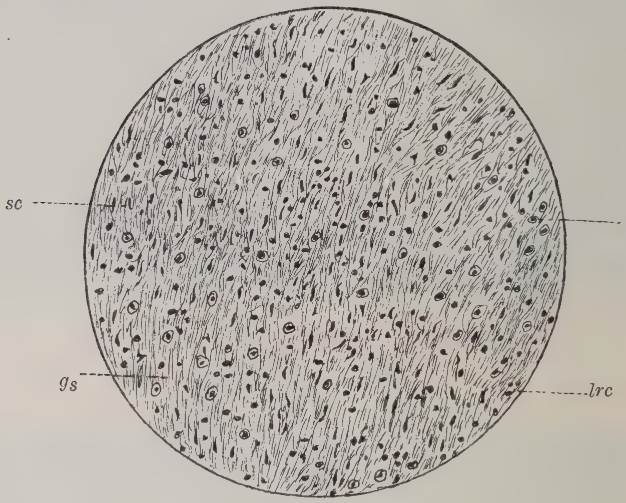


Fig. 940.—Spindle-celled sarcoma. (From a drawing by A. Hopewell-Smith.) The cells are arranged longitudinally except in places, where they are transversely cut.

which originated in the injured tissues. These varieties of sarcoma, when springing from the body of the bone, tend rapidly to invade the tissues and give rise to a distension of the bone in all directions, the arch of the teeth being considerably distorted. The periosteal type spreads with equal rapidity in all directions over the surface of the bone and extends down the sockets of the teeth, the bone itself being slowly eaten into by the growth.

Typical specimens are shown in figs. 937 and 938.

Microscopical sections of these growths are shown in figs. 939 to 941.



× 250.

Fig. 941.—Fibro-sarcoma. *sc*, spindle cells; *src*, small round cells; *lrc*, large round cells; *gs*, ground substance. (From a drawing by A. Hopewell-Smith.)

Malignant Melanoma.—This type of tumour is rare. In a paper published by New and Hansel[1] twenty-five cases are recorded. The following case[2] illustrates the features of this type of growth. A female, aged 62 years, noticed that an upper denture which she had worn for twenty years became uncomfortable, and on examining her mouth noticed a lump on the gum. When seen there was a bluish-black lump, almost gangrenous in character, about the position of the right molar tooth. It projected slightly from the surface; there was no ulceration and no gland enlargement. The growth

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[1] *Journ. American Med. Assoc.*, 1921, vol. lvii, 19.

[2] Reported by M. J. Stewart and J. Phillips, *Lancet*, July 1, 1922, p. 12.

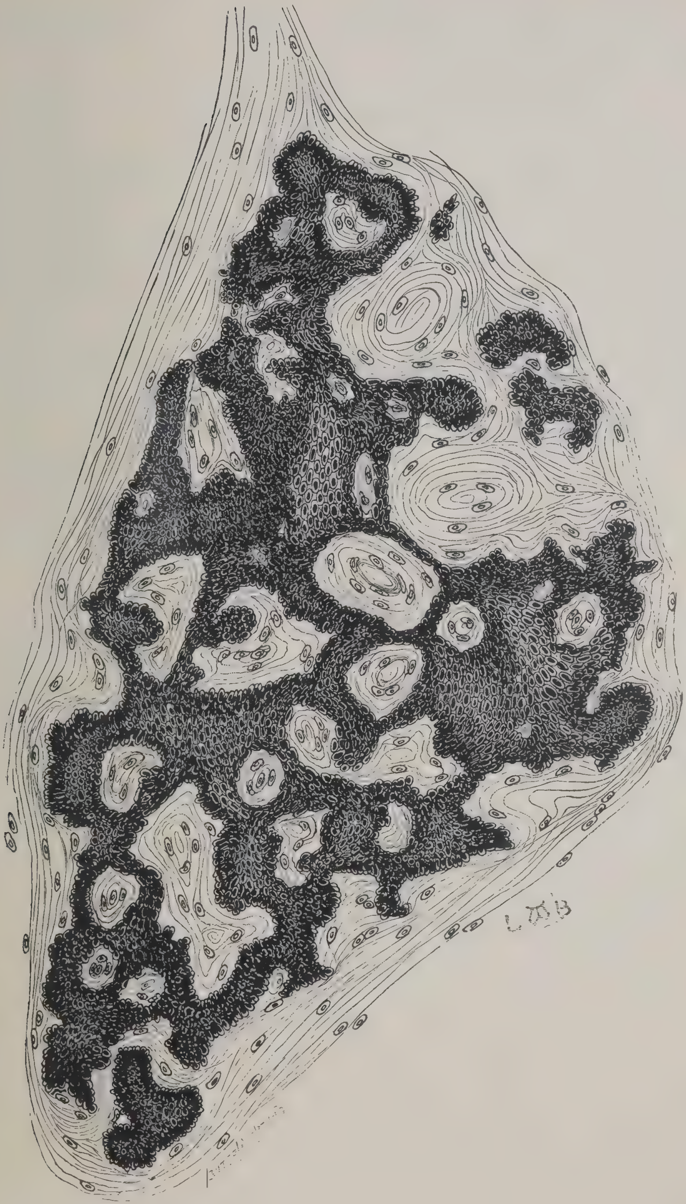

FIG. 942.—Microscopic characters of an endothelioma of the gum. (Bland-Sutton.)

was removed. The structure was a typical, richly cellular melanoma of the spindle-celled sarcomatous type.

The sarcomatous embryoplastic odontomes have been referred to under "Odontomes."

(D) Endotheliomata

Endotheliomata are tumours which arise in connection with the blood- and lymph-vessels. In the jaws they usually grow from the mucous membrane of the palate and are sometimes met with in the alveolar process. The microscopical features of an endothelioma are shown in fig. 942.

In a case recorded by H. A. T. Fairbank[1] there was a bright red vascular growth behind and slightly round the sides of a maxillary left second premolar. There was no enlargement of the alveolar process and the gland was not affected.

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[1] *Proc. Roy. Soc. Med.*, vol. iv (Odonto. Sec.), p. 12.

CHAPTER XXXIII

Diagnosis of Swellings about the Jaws

Swellings about the jaws are not always easy to diagnose, and it is often impossible to determine the exact nature of the growths without making a preliminary incision or puncture.

(A) SWELLINGS INVOLVING THE MAXILLA

For convenience these swellings will be considered under: (1) Those involving the maxillary sinus; (2) those originating in the alveolar process; and (3) those growing from the palate.

(1) Swellings involving the Maxillary Sinus.—A tumour may arise primarily in the maxillary sinus, or a growth, having its origin in the alveolar process, may involve this sinus secondarily.

In order that the clinical features of swellings of the maxillary sinus may be clearly understood a brief reference must be made to certain points in the anatomy of that sinus. The sinus may be regarded as a closed cavity, the boundaries of which, with the exception of the one formed by the alveolar process, are thin and yield readily to pressure. A distension of the cavity is therefore a sign of the presence of a growth. Expansion (i) of the facial wall, probably the least resistant, leads to a swelling on the face situated under the lower border of the orbit; (ii) of the orbital wall, to pressure symptoms on the eye, often accompanied by protrusion of the eyeball; (iii) of the nasal wall, to obstruction of the nasal passage; (iv) of the posterior wall, to pressure on the contents of the zygomatic fossa. The floor of the sinus formed by the alveolar process is of considerable thickness, and distortion of this wall as a rule only occurs in cases of malignant disease. The second division of the fifth nerve (superior maxillary) is in close connection with the sinus, entering at the spheno-maxillary fissure, traversing the infra-orbital canal, and opening on the face at the infra-orbital foramen. Implication of this nerve in a growth may give rise to persistent neuralgia before symptoms of distension of the sinus are apparent. The bony walls of the nasal duct, which are partly formed by the maxilla, may be invaded, leading to pressure on the duct, which is shown clinically by epiphora (overflow of tears).

(a) **Swellings arising primarily in the Maxillary Sinus.**—The *only fluid swelling* primarily arising in the sinus is the condition known as "cystic disease of the antrum." This gives rise to a slow but painless distension of the walls. The thin facial wall gives way more readily than the other walls which are more resistant, and the bulging on the face is therefore one of the most prominent symptoms. The swelling itself is smooth and globular, and, on pressure, may give rise to the sensation known as "parchment-like crackling." The alveolar border is not, as a rule, interfered with. In some cases the patient is aware of the presence of fluid in the sinus.

With *innocent solid tumours* there is a gradual distension of all the walls of the cavity, with the exception of the alveolar border. Epiphora may occur and severe neuralgia.

Malignant tumours give rise to a rapid distension of the facial, orbital, and nasal walls of the cavity, the alveolar process being involved in the later stage. Severe pain is frequently associated with malignant disease; the skin is implicated at an early stage, and the face becomes œdematous. The lymphatic glands do not become enlarged until the growth is well advanced.

(β) **Swellings involving the Maxillary Sinus secondarily.**—The sinus is frequently involved secondarily by tumours originating in the alveolar process. These tumours will be described under the next headings. Such swellings do not usually lead to distension of the cavity unless the growth attains a considerable size.

In *diagnosing between the swellings of the maxillary sinus* it is of primary importance to determine whether the growth is fluid or solid. This point may be determined by transillumination. The period of growth will enable innocent growths to be differentiated from malignant growths, a rapid growth suggesting malignant trouble. The rate of growth of tumours of the jaws is, however, not always easy to ascertain, the patient frequently being quite unconscious of the presence of any swelling in the mouth, and in other cases the swellings are not recognized in their early stages. The history given by a patient of the rate of growth must therefore be accepted with caution.

The solid innocent tumours occurring in the maxillary sinus are: (i) Fibroma, (ii) enchondroma, (iii) osteoma, (iv) myxoma. The differential diagnosis of these tumours is at times far from easy, more especially in the early stages, as they all give rise to distension of the walls of the sinus. Osseous growths are generally exceedingly slow in development, while fibromata and enchondromata may grow at times with great rapidity.

The malignant tumours occurring in the maxillary sinus are: (i) Carcinoma, (ii) sarcoma. The differential diagnosis between carcinoma and sarcoma can sometimes be arrived at from the age of the patient; growths in the young are invariably sarcomata, while those occurring in persons over the age of 40 may be either sarcomata or carcinomata. A tendency to hæmorrhage will indicate a sarcoma; and growths springing from the region of the malar bone are nearly always sarcomatous. In the case of malignant tumours a diagnosis should always be made from necrosis, especially when there is a large amount of inflammatory material and sloughing of the soft tissues. In doubtful cases, a portion of the diseased tissue should be microscopically examined before an operation is performed.

(2) Swellings originating in the Alveolar Process.—These may be divided into (*a*) those growing from the soft tissues covering the bone; (*β*) those growing within the bone.

(*a*) *The usual growths springing from the surface of the bone* are the various types of epulides and the true fibroma. Their diagnosis presents but little difficulty. The epulides spring from the margin of the alveolar process, usually from the septum between two teeth. The possibility of the growth being an excrescence from a tumour involving the body of the bone must always be considered. This condition is seen more particularly in connection with myeloid growths.

The true fibroma is of slow growth and is usually attached to the bone by a pedicle (see p. 840).

(*β*) *Swellings growing within the alveolar process* are the most important from the point of view of dental practice. These may be divided into fluid and solid.

The fluid swellings are:—

(i) Acute abscess.
(ii) Chronic abscess.
(iii) Dental cyst.
(iv) Follicular cyst (dentigerous cyst).
(v) Epithelial odontome.

The solid swellings are:—

(i) Fibroma.
(ii) Myeloma.
(iii) Calcified odontome.
(iv) Sarcoma.
(v) Carcinoma.

In diagnosing between these growths the fluid swellings must first be separated from the solid. Fluid swellings are indicated when fluctuation is present, and when the swelling is regular, smooth, and globular in character.

The differential diagnosis of the fluid swellings lies between chronic abscess, dental cyst, follicular cyst, and epithelial odontome. The teeth should be carefully examined, and, if septic teeth are present, the probability is that the swelling is either a dental cyst or a chronic abscess. The differentiation between these will be assisted by considering the history of the swelling. In the case of a dental cyst there is a history that the swelling has slowly but progressively increased in size; with a chronic abscess there may be a history of rapid swelling and of variation in size from time to time. The swelling from a cyst is usually more defined, and the fluctuation is more elastic in character than in the case of a chronic abscess. If, however, septic teeth are absent the growth is probably either a follicular cyst or epithelial odontome. With a follicular cyst a tooth is invariably absent from the series and the outline of the swelling is globular. With the epithelial odontome one or two teeth may be absent, and the swelling is frequently lobulated.

Fluid growths can be readily diagnosed from solid growths by the aid of radiograms.

As regards *the solid tumours*, the rate of growth must be ascertained in order to determine whether the growth is innocent or malignant in type. The endosteal fibroma leads to distension of the outer alveolar plate; there is no fluctuation, and the character of the swelling is not globular in outline as it is in the case of cysts. A calcified odontome tends to produce a swelling similar to a fibroma. A myeloma usually leads to a distension of both plates of the alveolar process, the outer plate giving way more readily than the inner. The swelling is generally distinctly lobulated in outline, but this is not always the case, and in the early stages a diagnosis between a fluid swelling and a myeloma is by no means easy. Carcinoma should be suspected in all cases of rapidly spreading ulceration of the gums. In these cases the growth usually extends to the maxillary sinus and there is often no apparent swelling over the facial surface, but in the later stage the walls of the sinus become distended and the occlusion of the teeth disorganized. A quickly growing tumour springing from the outer aspect of the bone is usually a sarcoma.

(3) Swellings in connection with the Palate.—The commonest fluid swelling in the palate is a chronic abscess. It generally arises in connection with the second incisor, but may be connected with a premolar or molar. The association of a well-marked fluctuating swelling with a septic tooth is sufficiently diagnostic. The possibility of the swelling being a gumma in the stage of breaking down must not be overlooked. The other fluid swellings that may occur are dermoid cyst (in the soft palate), follicular cyst, and aneurism of the descending palatine artery, but these are rare.

The solid tumours are: *Innocent*—(i) papilloma, (ii) fibroma, (iii) adenoma, (iv) osteoma. *Malignant*—(i) sarcoma, (ii) carcinoma. The papillomata are recognized by their characteristic appearance, but the possibility of the growth being an epithelioma in an early stage must not be overlooked. It is well to submit all papillomata after removal to microscopy. Fibromata may be recognized by their slow growth, their putty-like consistency, and, in many cases, their pedunculated character. Osteomata, in the form of so-called torus palatinus, are common. They are situated in the median line towards the back of the hard palate. Their extreme hardness and slow growth are sufficiently characteristic. Adenomata are rare. They give rise to solid sessile tumours and their true nature is often only apparent after operation, when they are found to shell out easily from the surrounding tissues. A fast-growing tumour springing from the hard palate is generally a sarcoma; and a carcinoma if it springs from the soft palate. Here again the possibility of the swelling being a gumma must be considered.

(B) SWELLINGS INVOLVING THE MANDIBLE

With swellings in the neighbourhood of the mandible the first step is *to determine whether or not the swelling is in connection with the mandible*, and, if it is, whether it involves the substance of the bone or is only connected with the bone externally.

(1) Swellings connected with the Bone externally.—These include the various types of epulides. Their attachment to the margin of the alveolar process is sufficient to establish a diagnosis, but here, as in the maxilla, the possibility of the growth being simply an excrescence of a tumour involving the body of the bone must be kept in mind. The other solid growths arising from the external aspect of the bone are: *Innocent*—(i) fibroma, (ii) enchondroma, (iii) osteoma. *Malignant*—(i) sarcoma, (ii) carcinoma.

Of the innocent growths, the fibroma usually springs from the bone in the neighbourhood of the median line; the enchondroma and osteoma from the inner side of the alveolar process near the premolars or the angle of the jaw. Malignant growths springing from the external surface of the bone tend rapidly to involve the overlying tissues, as is shown by the fact that the skin is adherent to the growth and not freely movable over the surface.

(2) Tumours involving the Body of the Bone.—The principal symptom will be gradual expansion of the two plates of the mandible, the outer generally yielding to a greater extent than the inner. Fluid swellings may be suspected when the bulging of the walls is quite smooth and globular in character; the outer plate may become so thin that, when pressed, the sensation of "parchment-like crackling" may be felt. If the swelling is fluid, a diagnosis will have to be made between chronic abscess, dental cyst, follicular cyst and epithelial odontome. The mode of diagnosis between these has already been mentioned.

An epithelial odontome is likely to be mistaken for a myeloma, and the diagnosis between the two is often very difficult, but with the former there will nearly always be an absence of a tooth or teeth from the series.

With solid growths, the character of the expansion of the bone is not so regular as in fluid collections, the inner plate being involved as well as the outer. With innocent growths the swelling will be of long duration, while with malignant the swelling is generally nodulated and always of quick growth. The innocent tumours may be either fibroma, enchondroma, myeloma, or osteoma; the malignant either epithelioma or sarcoma. Necrosis must be carefully diagnosed from malignant disease, and the likelihood of mistaking a calcified odontome for more serious mischief must not be forgotten.

CHAPTER XXXIV

Interference with the Movements of the Temporo-Mandibular Articulation (Closure of the Jaws)

Cases of restricted movement of the jaws or closure of the jaws are not uncommon. The treatment of these cases belongs, as a rule, to the domain of general surgery, but sometimes falls within the province of the dental surgeon. It is necessary therefore that the dental practitioner should be familiar with the various diseases which produce this condition and should be in a position to make a correct diagnosis.

(A) ETIOLOGY

(1) Causes connected with the Teeth.—The commonest cause of closure of the jaw is infection in connection with a partially erupted or misplaced mandibular third molar. In this condition the tooth sac, which is partly opened, becomes filled with stagnant matter; infection follows and spreads through the periodontal membrane and thence along the sheaths of the muscles. The inflammatory exudation leads to impediment to the movement of the muscles.

Infection around the second or first molars, or possibly infection around the maxillary molars, may spread to the soft tissues and cause closure of the jaws; but as a rule the interference with the movement of the articulation in these cases is not so marked as in the case of the mandibular third molar.

True spasm of the muscles from irritation of the nerves of the teeth is rare.

Chronic sepsis from the teeth may produce such an enlargement of the neighbouring lymphatic gland as to cause discomfort on movement of the mandible; this is particularly the case with enlargement of the lymphatic gland superficial to the parotid salivary gland.

(2) Tonsillitis.—In acute tonsillitis the infection may spread to the soft tissues covering the ramus and give rise to pain on opening the mouth. In these cases swallowing causes extreme discomfort; there is little or no swelling over the region of the face, but the tissues behind the angle of the jaw are usually swollen and tender to the touch.

(3) Malignant Disease of the Gums or Fauces.—Malignant disease in the region of the mandibular molars or fauces may lead to interference with the movement of the mandible. An increasing degree of difficulty in opening the mouth is at times the symptom for which advice is sought, the patient being quite unconscious of the presence of the malignant disease.

(4) Affections of the Parotid Gland.—Swellings of the parotid gland interfere with the free opening of the mouth by causing mechanical obstruction. The commonest cause of such swellings is an inflammation of the gland (parotitis) which may be specific (mumps) or secondary to infection in the mouth, which has spread up the duct. Another cause, but less common, is the presence of a tumour. Swellings connected with the parotid gland are situated below and in front of the ear, and the socia parotidis can usually be felt lying over the masseter. In mumps the condition is usually symmetrical.

(5) Spasm of Muscles.—Closure of the jaws from spasm of the masseter and other muscles is very rare. The muscular spasm is said to be due to irritation of the pulps of the second and third molars, but I have never seen a case of closure of the jaws which could be attributed to this cause. Spasm of the muscles occurs in the course of tetanus and strychnine poisoning.

(6) Diseases of the Articulation.—In *acute arthritis* there is swelling in the neighbourhood of the joint, the parts are tender to the touch, and any attempt to move the joint causes great pain. In that form of chronic arthritis known as *osteo-arthritis* the movements of the joint are mechanically limited by the formation of new bone around the joint surfaces. In the early stages there is only slight stiffness of the jaw, which is more in evidence in the morning. When the mouth is being opened, a clicking sound is audible to the patient and also to the surgeon. As the disease progresses, the stiffness of the jaw increases until, in advanced cases, the articulation becomes practically fixed, owing to alteration in the shapes of the articular surfaces. Osteo-arthritis may be suspected when a patient of forty years or upwards declares a history of gradual loss of power to open the mouth.

In *osseous anchylosis* the jaw is absolutely fixed, but in fibrous anchylosis a slight movement of the jaw can be obtained. There is usually a history of injury or infection of the joint.

In the rare condition known as *hypertrophy of the condyle* there is usually some restriction in the movement of the joint; the enlarged condyle can be felt on palpating the parts over the region of the joint; the chin is pushed to the opposite side and the face is distorted on the affected side.

(7) Cicatrices.—After severe ulceration, scar tissue may be formed to such an extent that the movements of the mandible are considerably restricted and even complete closure of the jaws may arise from this cause. The scar tissue which forms on the healing of wounds of the elevator muscles of the mandible invariably prevents the mouth from being opened to its fullest extent, the restriction of movement being most marked in the case of injuries to the tendon of the temporal muscle.

(8) Tumours which press upon the jaw from without may occur in the parotid or sub-maxillary regions, or in the situation of the deep cervical glands along the border of the sterno-mastoid muscle. *Deep-seated malignant tumours* may also lead to interference with the mobility of the jaw. Cases of this character are recorded by Coleman, Tomes, and others. This condition may be suspected when, after careful examination, other causes of immobility of the jaw have been eliminated.

(9) In a few cases the immobility of the jaw may be due to *exostosis of the zygomatic arch, ossification of the pterygo-maxillary ligament.*

(B) DIAGNOSIS

The diagnosis of the causes giving rise to closure of the jaws is best carried out by a process of elimination. The more common causes should be considered first, and these may be taken in the following order: Inflammatory infiltration of the tissues—the most frequent cause being dental, and then, possibly, mumps; arthritis; mechanical impediment from growths; mechanical impediment from scar tissue; hypertrophy of the condyle; and, lastly, rare conditions such as exostosis of the zygomatic arch.

(C) TREATMENT

If the trouble is dental in origin an anæsthetic should be administered, the mouth forcibly opened, and the offending tooth or teeth removed. Some difficulty may be experienced in opening the mouth, but a Mason's mouth-gag is generally effective. When the degree of trismus at first precludes the use of this instrument, the mouth can usually be forced open by a graduated wedge or spiral cone of boxwood. Instruments for forcibly opening the mouth must be employed with great care. After the extraction of the tooth the socket should be frequently irrigated and the pain relieved by fomentations. Complete recovery of the free movement of the jaw will often rapidly follow treatment, but in severe cases immediate recovery is not to be looked for. Where the third molar is concerned and it is not practicable to remove it, extraction of the second molar may give relief.

If the trismus is due to acute arthritis, wedges should be placed between the molar teeth and a four-tailed bandage applied in order to separate the articulating surfaces and relieve them from pressure. Fomentations should be applied over the region of the condyle. In osteo-arthritis the treatment in the early stages must be constitutional rather than local. The patient should be advised to avoid exposure to the weather as far as possible. For patients who must necessarily be much in the open air a cap with folds to tie over the region of the joint should be recommended. In the more advanced stages, when the jaw has become more or less anchylosed, the operation of excision of the condyle or section through some part of the ramus may be practised.

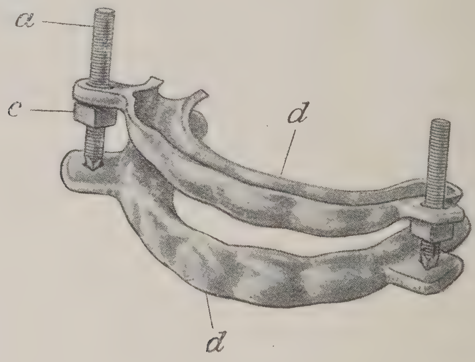

Fig. 943.

Osseous and fibrous anchylosis require for treatment the formation of a new joint; while for hypertrophy of the condyle excision of the joint may be necessary. If the closure of the jaw is due to cicatricial bands considerable benefit may follow the excision of the scar bands and periodical stretching of the tissues by means of a specially constructed mouth-opener. Fig. 943 illustrates a useful form designed by L. Guanziroli. It consists of shallow metal caps (*d*) covering the surfaces of the maxillary and the mandibular teeth. On either side of the lower cap square-shaped holes are made for the lodgment of the square-shaped tapering ends of the upright bars (*a*); by this means some play is obtained at the end of the bar. The upper part of each upright bar is threaded and passes loosely through holes in the upper cap. The apparatus is opened by moving the screws (*c*).

Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament are best treated by the formation of a new joint. If the trismus is due to external swelling, the treatment consists in seeking for and, if possible, removing the cause of the swelling.

CHAPTER XXXV

Some Common Affections of the Tongue met with in the Course of Dental Practice

Certain diseases of the tongue, more especially carcinoma, may first come under the notice of the dental surgeon, and it is most important that these diseases should be recognized at once by the practitioner.

(A) TONGUE WORRY

There is a condition of the tongue when the individual complains of indefinite pain and at times a pricking, burning sensation. There is no apparent lesion of the tongue. The condition is a source of considerable mental anxiety, and it is not easy to assure the individual that there are no signs of malignant disease. The term " tongue worry " would seem appropriate for this condition.

In some cases it can be traced to the constant friction of the tongue over the rough edges of teeth, and in these cases relief is only afforded by rounding off the edges of the teeth and polishing the surfaces.

In other cases it may be due to " cramming " of the tongue from a thick vulcanite denture. When this is the cause relief can be obtained by the use of a small metal denture. In other cases the condition is traceable to slight sepsis around the teeth.

Ballin[1] drew attention to the relation of vulcanite dentures to tongue irritation, and more recently W. G. Spencer[2] has stated that he has seen many cases of persistent irritation which have disappeared on the substitution of metal for vulcanite dentures. It is doubtful whether the irritation in this case is due to the chemical composition of the denture. A more probable explanation is that a growth of micro-organisms occurs on the roughened surfaces. There is no doubt that in some of these cases the metal surface affords relief.

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[1] " Diseases of the Tongue," 1900, p. 126.

[2] *Brit. Med. Journ.*, January 28, 1922, p. 131.

(B) CHRONIC SUPERFICIAL GLOSSITIS: LEUCOPLAKIA

This disease is practically confined to the papillated portion of the tongue. It is an inflammatory condition of the mucous and submucous tissues, with certain changes in the surface epithelium, which not infrequently progress to the formation of carcinoma. The disease is produced by some continued irritation, such as smoking, strong spirits, the habitual use of strong condiments, and chronic dental sepsis. It is very frequently seen in persons who have had syphilis, appearing as a late manifestation and uninfluenced by antisyphilitic treatment.

The disease does not affect the tongue uniformly, but occurs in patches. The earliest evidence is shown by a portion of the tongue becoming smooth, which is due to the disappearance of the papillæ. The epithelium becomes thinned, and the part affected presents a smooth reddened appearance, contrasting very noticeably with the adjacent papillated tongue. This is often known as the *red glazed patch.* Further changes in the epithelium cause the patch to assume a pearly bluish-white appearance. Such a patch is quite characteristic; it is perfectly smooth, and will be slightly depressed below the adjacent papillated area of the tongue. This is the typical *leucoplakia.* Both these appearances may be present on the same tongue, and the patches vary considerably in size and distribution.

At this stage there is no real pain, and hence, before advice is sought, the disease has probably been in existence for some months or years. The tongue may feel uncomfortably dry and stiff. If precautions are taken (i.e., all sources of irritation are removed and the tongue is kept scrupulously clean) patients suffering from the disease in this stage may have no further trouble. But too frequently an abrasion occurs in the thinned epithelium, bacterial infection ensues, and a *fissure* results. This is especially likely to happen on the borders of the tongue where friction is greatest, but fissures may occur in any of the patches. These fissures are extremely painful, and it is often at this stage that the patient first seeks advice. Under treatment fissures will often rapidly heal, but they frequently recur.

In some cases the disease does not progress further, but in others more serious changes develop. In a few cases the papillæ become much enlarged, and, proliferating, form a veritable tumour on the surface of the tongue. The name *ichthyosis* is given to this condition, and it is said that it always advances to cancer. Ichthyosis demands immediate and radical treatment. Far more common is the development of a *carcinoma*, either at the edge of a fissure or as a diffuse growth of the epithelium of one of the leucoplakial patches. A carcinoma demands prompt recognition and immediate treatment.

(C) ULCERATIONS OF THE TONGUE

(1) Simple. (*a*) *Dental.*—This is the commonest type of ulcer of the tongue. The predisposing cause is the sharp edge of a tooth, or the rough edge of a denture. In some cases the ulceration is quite superficial, but, nevertheless, is very painful when speaking or eating. The surface is usually surrounded by a zone of inflammation. In other cases the ulcer extends deeper, the edges being irregular and abrupt, the surrounding mucous membrane inflamed, and the floor of the ulcer bathed with pus. The lymphatic glands may become enlarged from sepsis. When dental ulcers have existed for some considerable time the edges and base may become indurated, and, in appearance, the condition may mimic carcinoma. Not infrequently a carcinoma may develop at the site of a simple ulcer. If there is any doubt about the character of the ulcer its edge should be submitted to microscopy.

Treatment consists in removing the cause. Rapid improvement and healing generally follow, but if this does not occur a V-shaped portion of the tongue containing the ulcer should be excised.

(*β*) *Injuries from other Causes than the Teeth.*—Ulcers may arise from burns, bites, stings, &c. The history of the case gives the clue to diagnosis.

Treatment.—An antiseptic mouth-wash is usually all that is needed.

(*γ*) *Dyspeptic* ulceration is most frequently met with near the tip of the tongue on the dorsal aspect. The ulcers are generally multiple and superficial, the portion of tongue around them being nearly always slightly inflamed, while symptoms of dyspepsia are present.

Treatment consists in attending to the dyspepsia, employing chlorate of potash mouth-washes, and, if the ulceration is very severe, brushing the surface of the ulcers with nitrate of silver.

(2) Infective. (*a*) *Syphilis.*—(i) A primary chancre is usually situated on the tip or the edge near the tip. It is characterized by the rapid formation of a hard nodule with superficial ulceration. The submaxillary glands are enlarged, and secondary symptoms of syphilis soon appear.

(ii) *Secondary.*—In the second stage of syphilis mucous tubercles may appear on the tongue. These tubercles consist of patches of enlarged and infiltrated papillæ, the superficial epithelium becomes soddened and gives rise to a characteristic yellow-white appearance. The surface of the mucous tubercles is liable to be injured, and ulceration of a septic type appears. The ulcer is therefore septic in character grafted on a syphilitic lesion.

(iii) *Tertiary.*—(*a*) *Deep intramuscular gumma* forming a nodule in the substance of the dorsum of the tongue. The swelling, which is painless, breaks down and forms a deep excavated ulcer. (i) The edges are sharply cut; (ii) the induration of the surrounding tissue rapidly disappears under treatment; (iii) the floor may present a wet washleather-like appearance in the early stages before the slough has disappeared; (iv) the situation of the ulceration is usually the dorsum of the tongue immediately to one side of the median line; (v) the submaxillary lymphatic glands are not as a rule enlarged; (vi) profuse salivation is not present; (vii) there may be pain, but not so severe as in epithelioma.

(*b*) *Multiple Superficial Gummata.*—These break down and form superficial ulcers.

(*c*) *Fissures and ulcerations* in connection with chronic superficial glossitis.

(*β*) *Tubercle.*—Tuberculous ulceration of the tongue is generally secondary to tuberculosis of the lungs or larynx and is due to a direct infection from the sputum. The common situation is the under-surface of the tip of the tongue. The ulcers are superficial, often multiple and very paintul. A zone of inflammation is present around the ulcer, and, occasionally, caseation of the floor can be seen. The coincidence of the ulcers with well-marked symptoms of tuberculosis of the lungs or larynx is sufficient to prevent the condition being mistaken for either syphilis or carcinoma. Occasionally, the clinical symptoms of the primary disease are not very obvious.

(*γ*) *Actinomycosis.*—Ulceration from this cause is rare. A hard, brawny swelling of the tongue forms and breaks down, giving vent to a gelatinous-like discharge containing the characteristic granules. Microscopy shows the nature of the disease.

(3) Malignant. (*a*) *Carcinoma.*—This most serious disease of the tongue may start:—

(i) In chronic ulcers or fissures, dental in origin, and very commonly situated at the borders of the tongue.

(ii) As a warty outgrowth, with infiltration of the base and surrounding tissues.

(iii) As a nodule.

(iv) In association with chronic glossitis originating in an ulcer, fissure, or ichthyosis, or appearing as a diffuse infiltration.

The characteristics of a carcinomatous ulcer are as follows: (i) Raised, sinuous, hard and everted edges; (ii) the surrounding mucous membrane is indurated; (iii) the floor irregular, in part excavated, and in part showing warty prominences and covered with a foul discharge; (iv) the base indurated, and, in the latter stage, the tongue fixed; (v) a darting pain; (vi) profuse salivation; (vii) enlargement of the neighbouring lymphatic glands (not in the very early stages); (viii) interference with speech and mastication. The disease is more prevalent in men than in women, and occurs generally in those past the age of 40.

Treatment is excision of a portion or the whole of the tongue, and the whole lymphatic area in the neck.

As before stated, early recognition of the disease is of the utmost importance. The presence of a wart on the side, tip, or, indeed, any part of the tongue in a person over 35 years of age should always be regarded with suspicion, and the patient *at once* advised to seek skilled assistance. All ulcers of some standing should be submitted to a careful examination. The particular points to which attention should be directed are: (i) The history of the ulcer; (ii) the character of the edges; (iii) the condition of the surrounding mucous membrane.

Ulceration in patients over 40 is always serious, and in doubtful cases it is better to have the suspicious portion excised.

(β) *Rodent ulceration* is extremely rare, and scarcely needs description here, and the same may be said of (γ) *sarcoma.*

CHAPTER XXXVI

Local Anæsthesia in Dental Surgery

By F. St. J. Steadman, L.R.C.P., M.R.C.S., D.P.H., L.D.S.

Certain drugs when injected have the power of producing a temporary paralysis of nerve fibres, which blocks the passage of impulses to the brain. The drug employed may be injected at the site of operation (submucous anæsthesia) or in the neighbourhood of the nerve trunks at some distance from the field of operation (regional or block anæsthesia).

A good *syringe* is essential to the obtaining of satisfactory results. It should consist of a stout metal barrel of convenient size (holding two cubic centimetres) and a washerless vulcanite plunger with a stop, which prevents its being withdrawn altogether from the barrel with an unpleasant jerk. The syringe should be capable of being taken to pieces and boiled if required, although it will deteriorate and will not work smoothly if boiled too frequently. The syringe is best kept in a large glass jar, which should be of sufficient size to immerse it completely.

If novocain is the drug employed, the following fluid, advocated by A. E. Smith,[1] will be found to keep the syringe in excellent condition, sterile and ready for immediate use:—

	Parts
Phenol	20
Sodium biborate	5
Glycerin	200
Peppermint water	30
Distilled water ... ... q. s. ad.	1,500
Misce.	

It is a good practice to wash out this fluid by passing a small quantity of cold boiled water through the syringe just before drawing up the injecting solution.

The plunger may be lubricated with a very small quantity of carbolized vaseline; but not too much should be used or the syringe nozzle will become blocked. Short nozzles should be used, as short as possible, for if the needle breaks it will do so at the weakest point, i.e., just where it emerges from the hub. So that if the operator makes it an inviolable rule never to insert the needle into the tissues up to the hub, a short piece will always be left sticking out, allowing the broken fragment to be rapidly and easily removed.

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[1] "Block Anæsthesia and Allied Subjects," by A. E. Smith.

The manufacture of irido-platinum needles at present leaves much to be desired, as they are expensive and break readily at the point of junction with the hub. Steel needles are cheaper and can be discarded after being used a few times.

There are two lengths of rustless steel needles, viz., forty-two and twenty-one millimetres. The long needles are required for the regional and the short for the submucous injections.

An angle attachment is needed for the maxillary molar injections.

The drug now most commonly employed is novocain (para-amino-benzoyl-diethyl-amin-ethanol hydrochloride). Cocaine of recent years has been almost entirely discarded, as it is a protoplasmic poison, is uncertain in its action, and is decomposed by boiling—a very great disadvantage. Novocain is a white crystalline powder capable of being heated to 120° C. without decomposition. It is synthetically prepared, so that its action is reliable and uniform. It is soluble in water (one part) and in alcohol (thirty parts). It keeps for several months without decomposition. It is seven times less toxic than cocaine. Its toxicity is so relatively light that 24 c.c., or twelve syringes full of a 2 per cent. solution, may be employed, a quantity that is very seldom, if ever, necessary for dental purposes. It is incompatible with lysol and alkaline carbonates. It possesses a great advantage in that it is not a habit-forming drug. When injected in an isotonic solution it does not produce irritation of the tissues, but the patient may notice a slight burning sensation for a few minutes after the injection, which is due to dilatation of the capillaries. It is a powerful local anæsthetic, producing an anæsthesia which is little inferior to that produced by cocaine, although its action is slower.

Suprarenin, the active principle of the suprarenal gland, can now also be prepared synthetically. It can be sterilized by boiling, but is liable to decompose if the boiling is prolonged. The solution sometimes turns a pale pink as it is being boiled, due to a slight oxidation of the drug taking place; the solution may, nevertheless, be safely used, provided the discoloration does not pass from a pale pink through red to brown. Suprarenin will keep for many months either alone or in tablet form with novocain, but not if calcium chloride is added. It is decomposed by alkalies. It is a powerful vaso-constricting agent, and for this reason prevents the rapid absorption of the local anæsthetic, so that not only is the duration of the anæsthesia much prolonged, but a larger quantity of the anæsthetizing drug may be employed without danger of toxic effects. Suprarenin is, however, itself highly toxic, and is the cause of the palpitation and slight distress which some patients experience a few hours after the injection. It is probably also responsible for the alarming symptoms of collapse which have been recorded in certain cases and wrongfully attributed to the toxic effects of novocain. It is contra-indicated in organic heart disease.

Compressed tablets of novocain either alone or in combination with suprarenin are manufactured by the Saccharin Corporation. The " F " tablets consist of ·05 grm. ($\frac{3}{4}$ gr. approximately) of pure novocain, and the " E " tablets of ·02 grm. ($\frac{1}{3}$ gr. approximately) and ·00005 grm. (1/1200 gr. approximately) of suprarenin. It is most important to distinguish between these two tablets; for whereas it is permissible to use seven or eight, or even more of the " F," not more than two " E " tablets should be used, otherwise there is danger of toxic symptoms due to an overdose of suprarenin supervening, manifested by profuse perspiration, dilatation of the pupils, pallor, laboured respiration and palpitation of the heart, followed by collapse.

It is important to inject these drugs in an isotonic solution, i.e., a solution containing salts of the same character and as nearly as possible in the same proportion as those in the blood. For the tissue cells are surrounded by a membrane through which water, but not salts, may penetrate by osmosis. If a hypertonic solution (a solution too rich in salts) is injected, the tissue cells become contracted and crenated; and if a hypotonic solution (poor in salts) is injected, the cells swell up and may actually rupture; both these conditions are a probable cause of after-pain.

To obtain the best results, it is advisable to prepare a fresh quantity of distilled water daily. Two ounces per diem will usually be sufficient for most operators. To this amount a " Ringer " tablet composed as follows is added, making approximately an isotonic solution[1]:—

Calcium chloride	0·011 grm.
Potassium chloride	0·011 ,,
Sodium chloride	0·51 ,,

Two drachms of this solution are boiled for a couple of minutes and one " F " and one " E " tablet added, and the whole boiled again for another minute. The solution is allowed to cool slightly and is then ready for injection.

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[1] These tablets are made by Messrs. Wright, Layman and Umney, Ltd., and may be obtained through any chemist.

This daily distillation may be a little troublesome, but it is most important to be able to rely absolutely upon the purity of the injecting solution. Moreover, it is probable that the use of stale distilled water is one of the causes of after-pain.

The mucous membrane through which the needle is to pass should be dried and painted with tincture of iodine. Great care should be taken that the area so treated should not be again contaminated by movement of the patient's tongue before the injection is made, and also that during the injection no part of the patient's lips or tongue should be allowed to touch the needle point. If such an accident occurs, the needle must be immediately withdrawn and re-sterilized before proceeding with the injection.

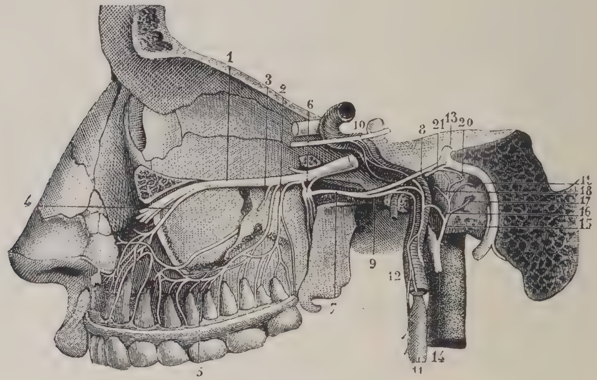

Fig. 944.[1]—Deep view of the maxillary nerve and the spheno-palatine ganglion. 1, Maxillary nerve; 2, posterior superior dental; 3, middle superior dental; 4, anterior superior dental; 5, superior dental plexus; 6, spheno-palatine ganglion; 7, Vidian nerve; 8, great superficial petrosal; 9, great deep petrosal; 10, a part of the sixth nerve, receiving twigs from the carotid plexus of the sympathetic; 11, superior cervical sympathetic ganglion; 12, its ascending branch; 13, facial nerve; 14, glossopharyngeal nerve; 15, its tympanic branch; 16, carotico-tympanic twig joining the sympathetic; 17, filament to the fenestra cochleæ; 18, filament to the Eustachian tube; 19, filament to the fenestra vestibuli; 20, small superficial petrosal nerve.

While a good knowledge of the fifth cranial nerve is necessary if the best results are to be obtained, a detailed anatomical description would be out of place in a work of this kind. However, a few essential points may be mentioned. The maxillary teeth are supplied by the second division of the fifth cranial nerve which leaves the skull through the foramen rotundum, crosses the spheno-maxillary fossa to enter the infra-orbital canal, along which it passes to emerge upon the face through the infra-orbital foramen, where it terminates in three sets of branches: the palpebral, nasal and labial (fig. 944). In the spheno-maxillary fossa the nerve gives off the superior dental branch, which descends upon the zygomatic surface of the maxilla, until, about half-way down, it pierces the outer surface of the bone to supply the third, second, and, frequently, the posterior buccal root of the first molar teeth. In the infra-orbital canal the middle superior dental branch passes in a canal in the outer wall of the maxillary sinus to supply the first molar and the premolar teeth.

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[1] From Sappey, after Hirschfeld and Leveillé. (Quain's "Anatomy.")

The canine and incisor teeth are supplied by the anterior superior dental branch, which leaves the main trunk about five millimetres before it emerges upon the face. These three nerves anastomose freely with one another forming a plexus, and, with the corresponding plexus of the opposite side, an outer nerve loop, which supplies the outer alveolar plate and overlying gum in addition to the teeth.

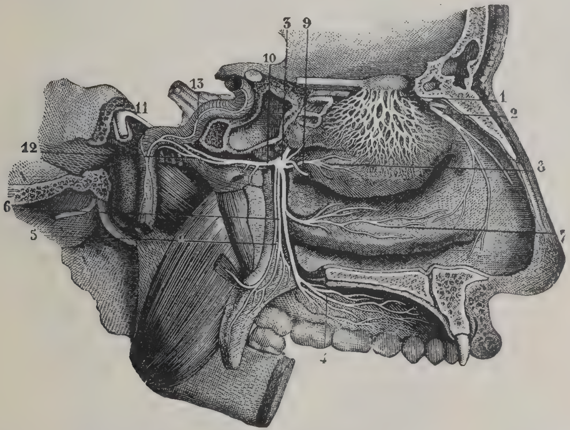

Fig. 945.[1]—Nerves of the nose and Meckel's ganglion. 1, Network of the external branches of the olfactory nerve; the area of distribution is not so large as represented here, and its fibres do not join to form a network; 2, naso-ciliary nerve, giving its external branch to the outer wall of the nose; the septal branch is cut short; 3, spheno-palatine ganglion; 4, ramification of the large palatine nerve; 5, small, and 6, external palatine nerve; 7, inferior nasal branch; 8, superior nasal branch; 9, naso-palatine nerve cut short; 10, Vidian nerve; 11, great superficial petrosal nerve; 12, great deep petrosal nerve; 13, the sympathetic nerves ascending on the internal carotid artery.

The hard and soft palate, the inner alveolar plate and the overlying gum are supplied by an inner nerve loop formed by the anterior palatine and naso-palatine branches of Meckel's ganglion (fig. 945)

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[1] From Quain's "Anatomy."

The mandibular teeth are supplied by the inferior dental nerves, which, by anastomosing with each other, form an outer loop to supply the outer alveolar plate and overlying gum. The lingual nerves forming an inner loop likewise supply the inner alveolar plate and gum (fig. 946). Another branch of the fifth also requires notice, namely, the long buccal nerve which supplies the inner side of the cheek and gum on the outer side of the mandibular molar

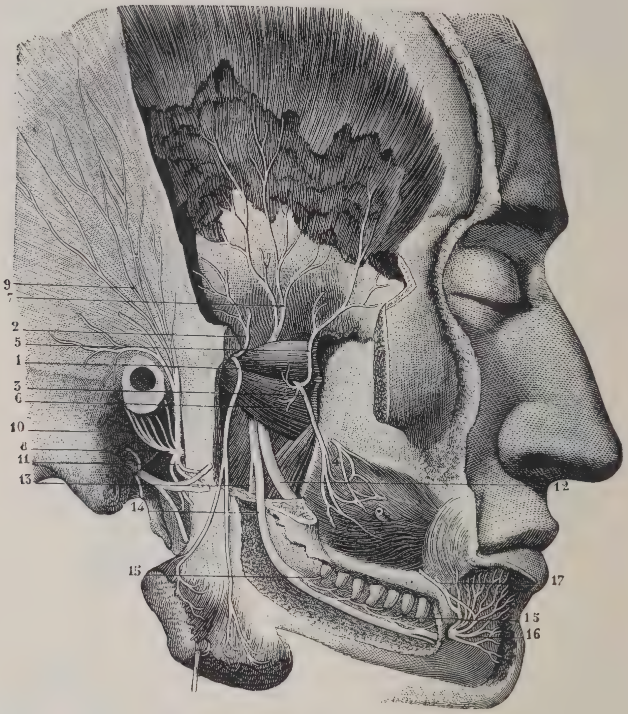

FIG. 946.[1]—View of the branches of the mandibular nerve from the outer side. The zygoma and part of the ramus of the lower jaw have been removed; the dental canal has been opened up; the lower part of the temporal muscle has been taken away, and the masseter muscle turned down. 1, Masseteric nerve; 2, posterior deep temporal nerve; 3, buccal nerve; 4, branch of the facial; 5, anterior deep temporal nerve; 6, filaments given by the buccal to the external pterygoid muscle; 7, middle deep temporal nerve; 8, auriculo-temporal nerve; 9, its temporal branches; 10, its branches to the meatus and auricle; 11, its union with the facial; 12, lingual nerve; 13, mylohyoid nerve; 14, inferior dental nerve; 15, its twigs to the teeth; 16, mental branch; 17, branch of the facial uniting with the mental.

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[1] From Quain's "Anatomy."

teeth (fig. 946). For extraction of teeth, the deep scaling of subgingival tartar, or the removal of cysts, it is necessary to block both loops; whereas for conservative work, such as the excavation of sensitive cavities, the extirpation of pulp, or apicectomy, the outer nerve loop only need be blocked.

If the outer and inner bony surfaces of the maxilla be examined, it will be seen that numerous canaliculi perforate the compact layers just above the apices of the roots of the teeth, but that in the mandible, except for a few canaliculi below the level of the roots of the canine and incisor teeth on the outside, and in the neighbourhood of the genial tubercles on the inside, these canaliculi are few in number. This is an important practical point, as these canaliculi greatly assist the infiltration of the anæsthetizing fluid.

Technique.

In *extensive operations in the maxilla*, such as the extraction of several or all of the teeth, or the removal of tumours or cysts, where both the outer and inner nerve loops are involved, the simplest method is to block the second division of the fifth cranial nerve as it crosses the spheno-maxillary fossa. Such an injection will catch not only all three of the nerves supplying the teeth and the adjacent parts, viz., the posterior, middle and anterior superior dental nerves, but also Meckel's ganglion, from which is formed the inner nerve loop. If all the upper teeth are to be removed, this injection must be done on both sides, or if the teeth from one half of the jaw only, then one injection in the spheno-maxillary fossa will suffice, provided that the overlapping branches from the anterior superior dental and the naso-palatine nerves of the opposite side be anæsthetized.

The distance between the reflection of the mucous membrane from the maxillary tuberosity and the nerve trunk itself is from twenty-seven to thirty-three millimetres, therefore, in accordance with the rule already laid down that the needle should never be inserted up to its junction with the nozzle, a long needle is required. One may use either a right angle irido-platinum forty-millimetre needle, or a long rustless steel needle joined to the syringe by the angle attachment. The point of insertion of the needle is behind the tuberosity of the maxilla at the highest point of the reflection of the mucous membrane of the cheek to the bone, that is to say, above and to the buccal aspect of the roots of the third molar. The point of insertion should be well away from the gum margin, and the needle should be advanced in an upward, inward, slightly backward direction for a distance of about thirty millimetres. If the direction is correct the needle will slip in easily and painlessly (fig. 947). If, however, the direction is too far backwards, the point of the needle will strike against the greater wing of the sphenoid and its further passage will be prevented. Should this happen, it is necessary to withdraw the needle and change its direction. On the other hand, should the needle point be directed too far forward, it will be caught up in the periosteum overlying the maxillary tuberosity. Two cubic centimetres of a 2 per cent. solution of novocain should be slowly injected. Occasionally, at the moment of the commencement of the injection, there is a transitory blanching of the area of the skin of the face which is supplied by the second division, owing to the contraction of the corresponding arteries. A profound anæsthesia extending over the cheek as high up as the lower eyelid, as far forward as the inner side of the nose, downwards to the upper lip, and backwards along

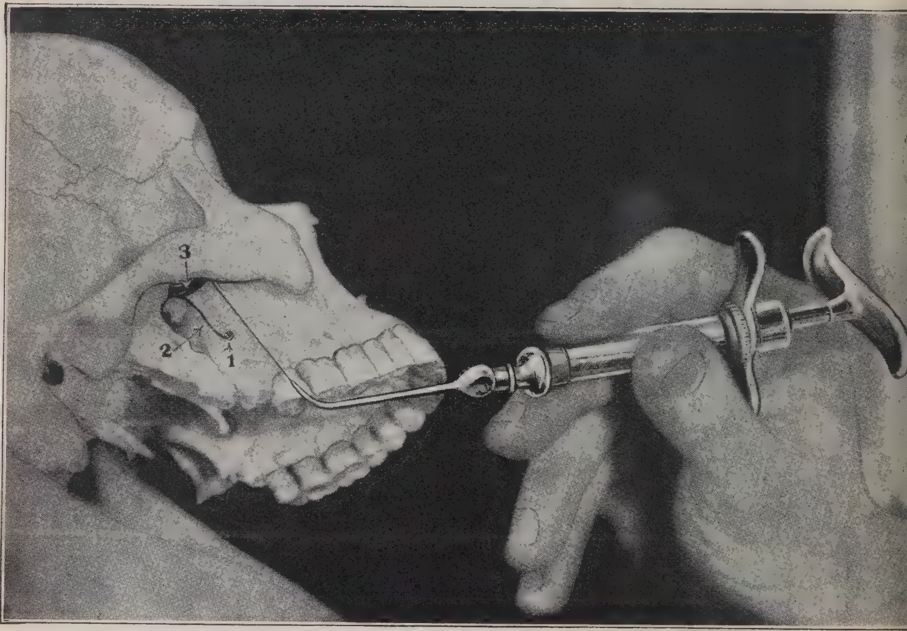

Fig. 947.[1]—Showing position of needle when anæsthetizing the second division in the spheno-maxillary fossa.

1. Posterior superior dental foramen.
2. Posterior superior dental nerve.
3. Second division of the fifth nerve crossing spheno-maxillary fossa.

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[1] From Smith's "Block Anæsthesia." (Henry Kimpton.)

the cheek in a line with the mouth, will develop in from about twenty-five to thirty-five minutes. If this injection is made on one side only, the three molars and two premolar teeth may be safely removed. If it is intended to remove the canine and incisor teeth also, it will be necessary to block the overlapping branches of the anterior superior dental nerve of the opposite side by a sub-mucous infiltration over the apex of the canine, and an injection in the palate behind the second incisor at about the level of its apex. Occasionally the patient experiences a slight twitching sensation in the eye, followed by diplopia, which usually passes off in about twenty minutes. Should this happen, care should be taken to explain to the patient that there is no cause for alarm.

For operations upon the *second and third maxillary molar teeth* it is only necessary to block the posterior superior dental nerve, which can be easily caught, as it enters the canal about half-way up the posterior surface of the zygoma. For this injection a short needle and the same angle attachment before mentioned should be used. The point of insertion of the needle is behind the root of the zygoma at about the level of the apex of the posterior buccal root of the second molar (fig. 945). The needle is advanced in an upward, backward and inward direction through some of the fibres of the buccinator and external pterygoid muscles, care being taken to keep fairly close to the bone, but not close enough to pass under the periosteum. This injection is painless, and very simple. If a straight attachment to the syringe is used, there is a risk of pushing the needle backwards into, and even through, the fibres of the external pterygoid muscle, behind which is the internal maxillary artery, and of missing the nerve altogether (fig. 948).

Anæsthesia develops in from three to five minutes, when cavities in these two teeth may be prepared, or their pulps extirpated. If extraction is required, the anterior-palatine nerve must be anæsthetized by a palatal injection, the needle being inserted exactly half-way between the mid-line and the margin of the gum a little behind the root of the third molar.

For operations upon the *maxillary first molar* the same injections are required. In addition to these injections, however, a sub-mucous, sub-periosteal injection should be made over the apex of the anterior buccal root to catch the middle superior dental nerve which supplies it.

For operations upon the *premolars*, the sub-mucous and sub-periosteal injection above the level of their apices will generally suffice for conservative work, with an additional palatal injection; also above the apices of the roots for extraction.

For operations upon the *canine and incisors*, either an infra-orbital regional or a sub-mucous, sub-periosteal injection above their apices may be employed. For the infra-orbital injection a long straight needle with a short straight nozzle is used. The infra-orbital foramen is first palpated. It will be felt a finger's-breadth below the junction of the inner and outer two-thirds of the infra-orbital margin. With the pulp of the forefinger over this spot the lip is held outwards between this finger and thumb, and the needle is inserted into the mucous membrane, in the inner side of the cheek opposite the second premolar, two or three millimetres from the point of reflection of the mucous membrane from the bone. It is now advanced along the direction of this root directly to the infra-orbital foramen. The fluid is then deposited under the pulp of

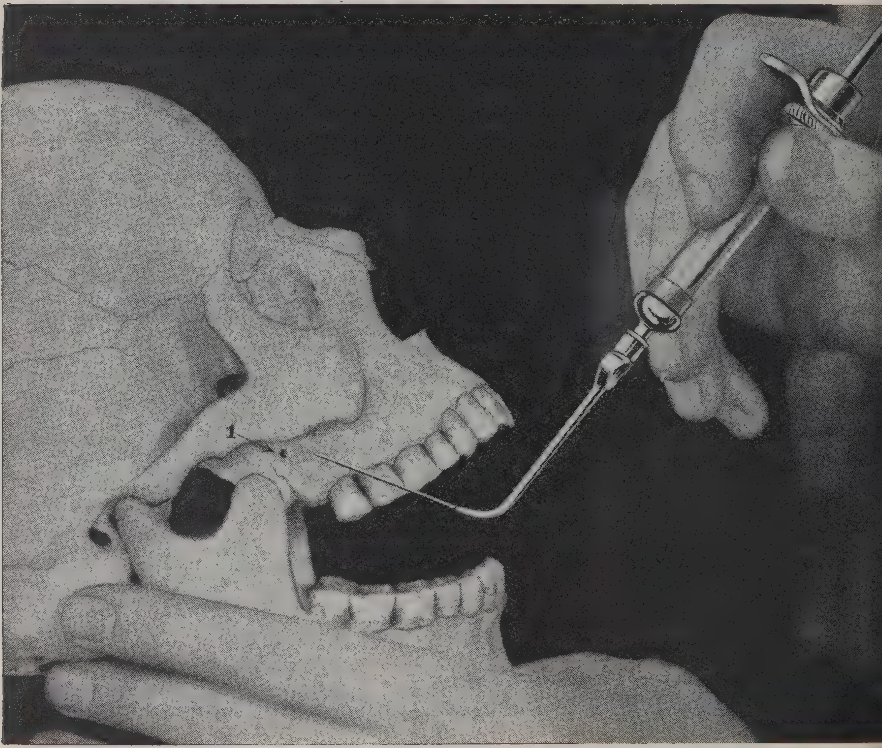

Fig. 948.[1]—Showing the needle advancing to the posterior superior dental nerve.

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[1] From Smith's "Block Anæsthesia." (Henry Kimpton.)

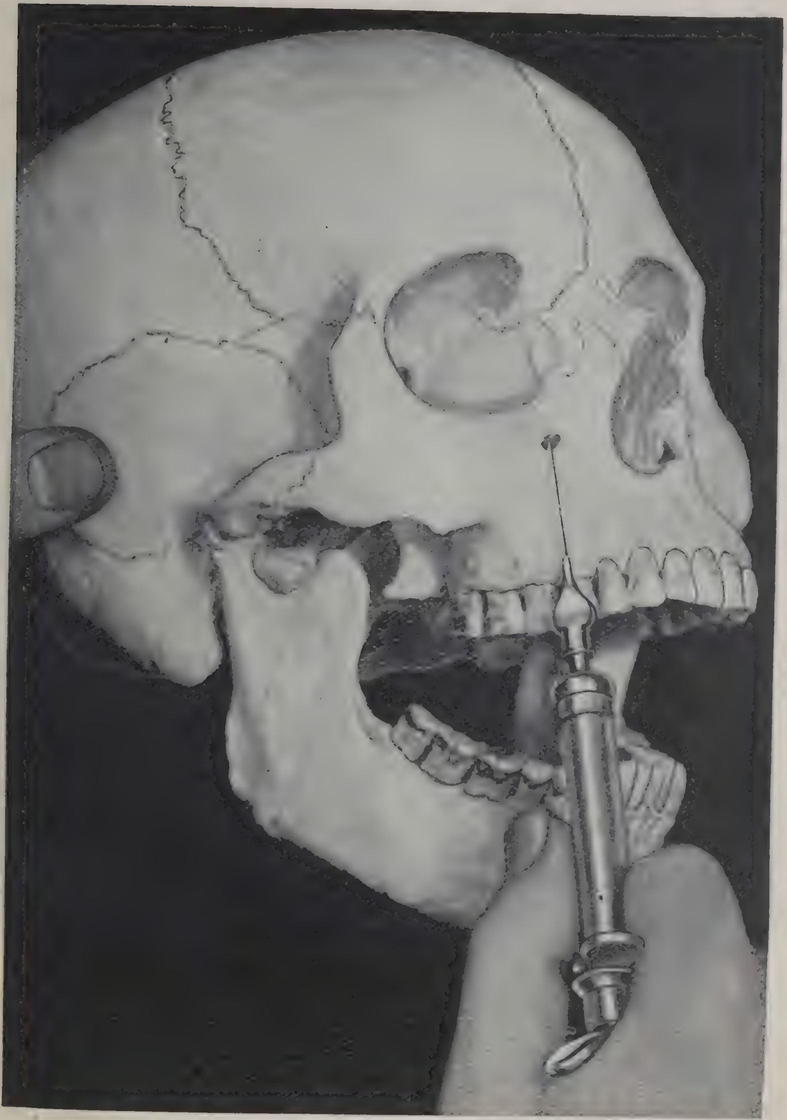

FIG. 949.[1]—Injection at the infra-orbital foramen.

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[1] From Smith's "Block Anæsthesia." (Henry Kimpton.)

the forefinger and massaged in an upward and backward direction towards the infra-orbital canal (fig. 949). Anæsthesia will develop in about ten minutes. In this injection great care must be taken not to insert the needle point too close to the point of attachment of the mucous membrane to the bone, otherwise it will be caught up under the periosteum in the canine fossa, when it would be found that further advancement is impossible. A full ten minutes must be allowed to elapse before operation, even though the patient states that a numbness is felt in the cheek. This numbness is due to the anæsthetization of the terminal branches of the infra-orbital nerve, which, being nearer the surface, become affected before the anterior superior nerve is reached. For extraction of these teeth the overlapping branches from the opposite side must be anæsthetized by a sub-mucous, sub-periosteal injection above the level of the apices of the teeth, an injection must

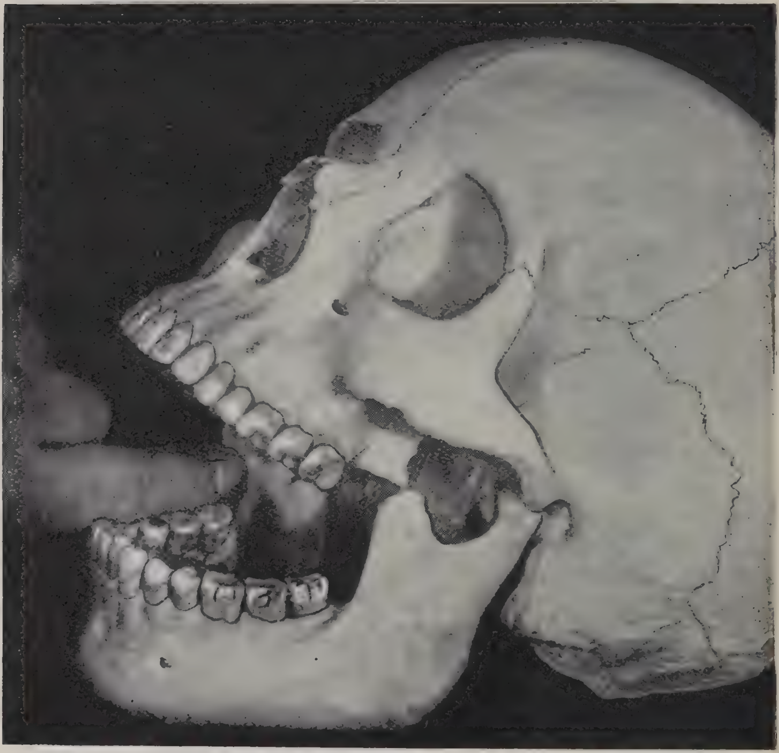

Fig. 950.[1]—Showing the finger on the internal oblique line.

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[1] From Smith's "Block Anæsthesia." (Henry Kimpton.)

also be given in the palate behind the first incisor teeth, just to one side or other of the mid-line and about half-way between the gum margin and the level of their apices. This injection is painful, but the pain may be overcome by a superficial injection of the gum with half a cubic centimetre of fluid, using a very fine needle a minute or two before making the deeper injection.

For operations upon the *mandibular molar teeth* it is necessary to give an inferior dental regional injection. For, owing to the density of both the outer and inner alveolar plates, it is impossible to be sure of obtaining satisfactory results by a sub-mucous infiltration.

To give the injection for the right side the operator should stand in front of the patient and place the pulp of the forefinger of his left hand along the external oblique line, and then rotate it inwards through a quarter of a circle (fig. 950). The finger tip will now be in the retro-molar fossa, with the nail in contact with the mucous membrane over the internal oblique line. The long straight needle is now inserted into the mucous membrane, close to the middle of the operator's nail, with the barrel of the syringe lying in the left corner of the mouth, and is cautiously advanced until the bone is felt at this point. The needle is now slightly withdrawn and the barrel swung over to the opposite angle of the mouth—that is, the right—and pushed in a backward direction for about three or four millimetres, when half a cubic centimetre of fluid may be injected to catch the lingual nerve (fig. 951). It is then pushed a little further backwards and the barrel swung over to the left angle of the mouth, and the needle cautiously advanced until the bone is felt. The needle point will now be in close proximity to the inferior dental nerve trunk, and the remaining fluid is deposited. For the injection on the left side the left forefinger is hooked round the angle of the mouth and placed on the external oblique line. It is then advanced slightly forwards until the internal oblique line is felt and the injection carried out as before. The patient will experience a slight tingling, followed by a numbing sensation at the corner of the mouth about fifteen minutes after the injection. The operation may be safely carried out about five minutes later.

For extraction of the *mandibular second and third molars* it is necessary to give an additional injection of half a cubic centimetre for the long buccal nerve. For this operation the needle is inserted midway between the cheek and gum opposite the second molar. These injections will anæsthetize the teeth as far forward as the second premolar. If it is required to remove the teeth which are further back, the overlapping branches of the opposite side must be injected by a sub-mucous, sub-periosteal injection inside and out in the manner which is described below.

For operations on the *mandibular premolar teeth* an injection at the sub-mental foramen will suffice. First palpate for the foramen, which is usually to be found below and between the apices of these two teeth. Sometimes, however, it may be found immediately below the apex of the first premolar, or below the apex of the second, and sometimes, even, just behind this apex. If difficulty is experienced in finding the foramen it can generally be located by making fairly firm pressure low down in the sulcus. The patient feels a slight pain when the pressure is applied at the point where the mental nerve curls round the sharp anterior border of

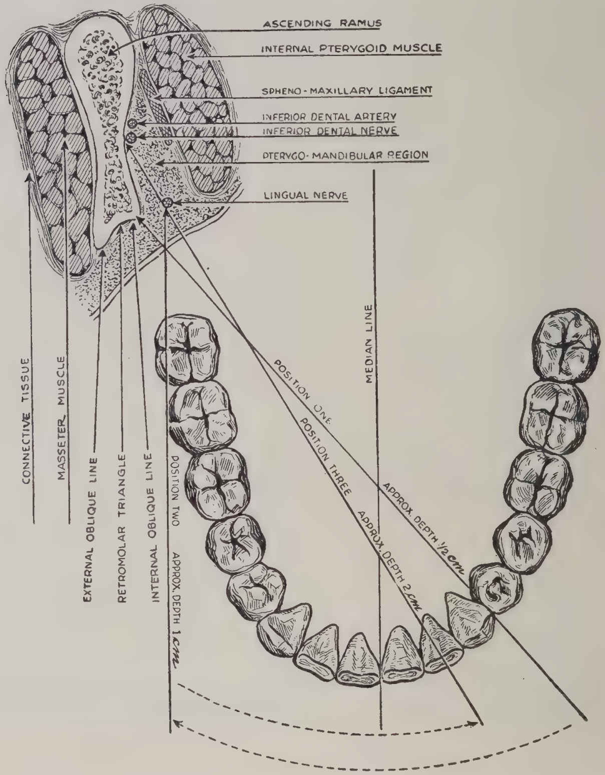

FIG. 951.[1]—Illustrating the three positions of the syringe for the mandibular injection.

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[1] From Smith's "Block Anæsthesia" (Henry Kimpton).

the foramen. It is important to push the needle point into this foramen. The syringe is held, pen-fashion, parallel to the line of the roots of the teeth and inserted into the mucous membrane two or three millimetres buccally from the junction of the membrane to the bone, and advanced straight downwards into the foramen. After injection the fluid should be massaged well into the foramen. If these teeth have to be removed, an injection in the terminal branches of the lingual nerve should be made sub-periosteally below the level of their apices on the lingual side. The double sub-mental injection will anæsthetize the lower incisors and canines, in addition to the first premolars. To anæsthetize the lower incisors and canines an injection may be made in the incisive fossa. The needle should be inserted into the inner side of the lip about two or three millimetres from the point of reflection of the mucosa from the bone. Anæsthesia develops in from three to five minutes.

Sequelæ.

After-pain.—In a certain number of cases after-pain may occur, varying from a slight amount, lasting for an hour or so, to a severe pain which may last three or four days, or even longer. It is extremely difficult to know how much of this pain may be fairly ascribed to the local anæsthetic. After-pain of very much the same character is not infrequently met with after general anæsthesia and in cases when no anæsthetic whatever has been given. After-pain is generally due to sepsis. Careful inquiry into cases of pain following upon extraction of teeth seems to show, however, that it is very little, if any, more frequent after local than after general anæsthesia. The chief causes of after-pain are faulty technique, such as, for instance, injections into muscle or ligaments, scratching the periosteum over the bone, the non-use of an isotonic solution, or the use of a solution too hot or too cold. The administration of too large a dose of suprarenin may lead to excessive contraction of the vessels, and the socket fails to fill with blood. In these cases there is often considerable after-pain due, probably, to exposure of the nerve endings.

In a certain number of cases, even when every precaution has been taken, after-pain occurs which cannot be traced to any cause.

Treatment.—Massage of the area of operation when the after-pain occurs frequently relieves it very rapidly. Failing this, hot dry flannels round the head, the application of the high frequency current, internal administration of drugs, such as aspirin, or a hypodermic injection of morphia in extreme cases may be prescribed.

Toxic Symptoms.—Occasionally toxic symptoms may follow a local injection, which vary from a slight palpitation of the heart coming on two or three hours after the injection, and which is undoubtedly due to the suprarenin, to more pronounced symptoms, which may arise soon after the injection. The prominent features are profuse perspiration, dilation of pupils, pallor, throbbing of blood-vessels in the head, laboured and irregular respiration, rapid weak pulse, occasional vomiting, and, sometimes, collapse.

Treatment.—Place the patient in a recumbent position, with the head low, loosen all tight clothing, and direct the patient to take deep breaths; if necessary, perform artificial respiration. Half to one teaspoonful of sal-volatile in water may be given internally, followed by a cup of hot coffee. In severe cases a cardiac stimulant, such as a hypodermic solution of strychnine sulphate (1/30th of a grain), or if there is respiratory failure, 1/120th of a grain of atropin sulphate may be given.

Contra-indications.

Local anæsthetics must not be given indiscriminately. They should be avoided in patients who are in a low state of health, such, for example, as those just recovering from an attack of influenza, and in patients with arteriosclerosis and organic heart disease. In heart disease, as a general rule, general anæsthesia is safer than local anæsthesia.

CHAPTER XXXVII

Radiographic Changes in Chronic Infection of the Jaws

STANLEY COLYER, M.D.Lond., D.M.R.E.

(A) NORMAL DETAILS TO BE OBSERVED IN DENTAL RADIOGRAMS

IN examining dental radiograms (negatives) the following anatomical details should be remembered:—

(1) The Lamina Dura.—This will be seen as a thin white line of compact bone covering the cancellous tissue of the alveolar processes. It lines the sockets of the teeth, and at their upper ends joins the lamina dura covering the tops of the interdental septa.

(2) The Periodontal Membrane.—This is shown as a fine black line between the shadow of the root and that of the lamina dura. For practical purposes it should be considered as normally the same breadth throughout.

(3) The Cancellous Tissue.—It is not possible to give a definition of normal cancellous tissue. Its recognition is largely a question of the thickness of the individual trabeculæ, the angles at which they meet, and their general arrangement; and to these may be added a knowledge of the tissue in its diseased states. There are certain gross differences between the cancellous tissue of the two jaws. The arrangement of the trabeculæ depending upon strains and stresses, those of the maxilla take, roughly speaking, the pattern of a fine irregular small-meshed honeycomb, whilst those of the mandible form largish irregular spaces which have a general tendency downwards and forwards. These latter are seen most characteristically in the premolar and first molar regions. Towards the incisor region where the stress is mainly vertical the tissue is arranged somewhat similarly to that of the maxilla.

(4) The Foramina.

(*a*) *The Anterior Palatine.*—In obliquely-taken radiograms the shadow of the foramen may frequently be seen in relation to the end of an incisor tooth.

(*b*) *The Posterior Palatine Foramina.*—The shadows of these may become related to the root of a molar.

(*c*) *The Mental Foramen.*—This should be looked for towards the ends of the mandibular premolar roots.

(*d*) *The Teeth.*—It will be seen that the enamel can usually be distinguished from the dentine, and the dentine sometimes from the cement. Normally the dentine shadow cast by a root absorbs, so to speak, the shadow of the cancellous tissue, except occasionally towards the end of tapered roots.

The technique used in producing the radiograms illustrating this chapter brings about certain changes in the length of the shadows representing the roots. These are as follows:—

(*a*) *In the maxilla.*

The first and second incisors and canines should be approximately normal. Occasionally lengthening or foreshortening occurs, and is due to faulty technique.

The premolars on a film showing the canine are shortened, whilst on one showing the molars they should be approximately normal.

The molars.—The palatine root is seen through the floor of the maxillary sinus and is lengthened. The buccal roots are foreshortened, placed a little back, and their shadows are for the most part merged into the general shadow of the body of the tooth.

(*b*) *In the mandible.*

The incisors generally show a little foreshortening.

The premolars on the canine film are foreshortened, and on the molar film are of approximately normal length.

The molars should appear normal.

NOTE.—Only clear and undistorted portions of a film should be studied. The student is advised to read through the remainder of this chapter before studying the illustrating radiograms.

(B) RADIOGRAPHIC CHANGES IN CHRONIC INFECTION OF THE JAWS

The radiographic changes brought about by chronic infections of the jaws will be considered under the headings of (1) Infection viâ the Gingiva, and (2) Infection viâ the Apical Foramina.

(1) Infection viâ the Gingiva

In the early stages there is a solution of the condensed bone (the lamina dura) covering the edge of the alveolar process. The infection then passes into (1) the periodontal membrane, and (2) the medullary tissue of the interdental septa. The periodontal membrane shadow becomes thicker. The increase in breadth of this membrane requires an increase in breadth of the space in which it is housed. This increase is brought about either by a rise of the tooth in its socket, or by absorption of the outer surface of the lamina dura. The latter is the more common; the lamina itself disappearing, or in the less severe infections increasing in breadth by a deposition of bone on its inner surface *pari passu* with its absorption on its outer or dental surface. Thickening of the periodontal shadow is sometimes apparently limited to the cervical portion, but more commonly the whole membrane shows an increase which is somewhat more marked towards the lower one-third of the root. The thickening of the lower portion may be due to the anatomical disposition of the tissues, or to the increased strain from mastication at this point brought about by the inflammatory softening of the suspending fibrous tissue. Under certain conditions the persistence of the infection about the apex brings about a further inflammatory thickening of the periodontal membrane which, when of sufficient degree, becomes known as a "granuloma." Radiographically a granuloma is shown by an area of increased translucency which, as a rule, is surrounded by a fine line of increased opacity representing sclerosed bone. To some extent, therefore, a granuloma may be considered an encapsuled infection. Such areas of clear translucency may also represent dental cysts or chronic abscesses, the radiographic differentiation of which may be difficult or even impossible. Cysts, perhaps, give more brilliant shadows than granulomata owing to the fact that the surrounding tissue is not so likely to be invaded by inflammatory products; and a granuloma in turn should give a clearer shadow than an abscess. It follows that the diagnosis of an abscess rests to a large extent upon the haziness of a tissue with or without the presence of a more or less clear area of translucency.

From the periodontal membrane the infection passes into the surrounding bony tissue. This is an obvious pathological necessity that too often is overlooked. It cannot be too strongly emphasized that infections of the jaw are never, except in their very early stages, and sometimes in their later partly cured stage, of a localized character, but always more or less diffuse. The reactive changes subsequent upon an infection, comparatively easily diagnosed, stand as evidence of the extent of the previous infection. In certain cases the infection will be found to have involved the whole of the alveolar processes, the palatal processes of the maxillæ, and parts of the walls of the sinuses; or, to put the question more shortly, the infection has for practical purposes produced a chronic pan-osteomyelitis of the jaws. In view of this diffuseness such terms as "focal infection" and "apical infection" are misleading; they suggest mental pictures of circumscribed infections which are not borne out by radiographic evidence. It is the recognition of this diffuse infection that makes the interpretation of dental radiograms an expert science—not necessarily limited to radiologists—and requires in the observer a previous knowledge of both dental and general pathology.

The changes produced in bone, whether the infection be from the dental pulp, the periodontal membrane, or the alveolar edge, are the same and will now be described under the last.

The changes that take place in bone vary considerably, but all are essentially dependent upon the two inflammatory changes of bone known as rarefaction and sclerosis.

Rarefaction, or Porosis.—Rarefaction of bone is primarily due to the invasion of the myeloid tissue by bacteria, which in due course lead to the formation of inflammatory tissue containing osteoclasts. The presence of such tissue when the irritation is of a suitable type leads to the absorption of some of the bony trabeculæ, and thus to the formation of irregular spaces outlined by the remaining trabeculæ. At the edge of the alveolar process where the inflamed mucous membrane is joined to the bone such rarefaction spaces often remain as open pits of varying size. Rarefaction areas formed in the way here described are but slightly more translucent than the surrounding tissues, and much patience is at times required to detect them. They may be quite small or comparatively large, or a largish area of tissue may be faintly rarefied. These largish diffuse areas of rarefaction, which are generally missed by observers, can often be seen by standing some little distance from the radiogram, or by viewing them "on the slant." Although it is a point difficult to prove these diffuse areas almost certainly represent masses of bone undergoing slow destruction, and they are probably more dangerous to the patient than more or less circumscribed areas about which obvious reparative changes have commenced. Such diffuse areas of faint rarefaction may in time become either more sclerosed than the surrounding bone or the rarefying process may continue until all bony structure disappears —the inference being that its place has been taken by a mass of inflammatory tissue. About the area of increased translucency the bone for some distance is more or less sclerotic. These cases are often referred to in books as osteomyelitis of the jaw, and they certainly are such; but they are no more entitled to this description than are the less obvious changes already described.

Sclerosis, or Condensation.—Where the irritation is not so intense there will occur a condensing osteitis. It is for this reason that areas of rarefaction, whether large or small, become defined in time by a white line of sclerosed bone. As the reparative changes gain on the destructive the sclerosis moving centripetally tends to close up the space, which in time becomes rounded. At a later stage still the rarefied area is represented by a small, round, darkish dot surrounded by a layer of compact tissue. These particular spots, in my opinion, are diagnostic of bone infection, and they should always be carefully looked for. They may not necessarily show even when present unless the film, the tissue, and the X-ray are in happy combination. Though showing as spots it does not follow that they represent small ball-like masses of tissue, as the soft tissue enclosed may be ovoid, or even sausage-shaped. They have to be distinguished from the small nutrient foramina conveying vessels from the periosteum. These canals when seen in radiograms are more ovoid in shape, their surrounding bone is thin, and from them the bony trabeculæ which are not sclerosed pass in a normally irregular manner. The sclerosed bone about the round spots may continue to invade the dark central portion until it entirely disappears, and nothing is then to be seen but a small patch of sclerosed tissue. This small patch of sclerosed tissue represents a cured mass of chronically inflamed bone. It is important to bear this last possibility in mind as it gives one a reasonable hope for assuming that the jaw-bone may at times, even if rarely, completely recover from infection. To repeat: These "small dark spots surrounded by sclerosed bone" are evidence of chronically infected bone of the jaw, and also of an endeavour of the tissues to rid themselves of the infection. Radiographically speaking, the proofs of their infective nature are indirect, and are these: (1) They may often be seen in bone about an obviously infected root; (2) they are frequently seen in the substance of interdental septa the subject of chronic inflammation, and (3) they may at times be seen in what may appear to be an otherwise normal-looking septum right up against a cementosis on a root which is surrounded by a radiographically normal-looking periodontal membrane.

A *general sclerosing* of the cancellous tissue without obvious alteration of its pattern is frequently seen, especially in that type of person known a few years ago as the "gouty type." The cause may be, as far as one can judge, a diffuse infection of a very mild character in which destructive changes do not occur.

In addition a *diffuse form of sclerosis* should be looked for. This type is frequently seen in interdental septa which have been infected over a long period. Such altered septa may often be seen in jaws of patients the subject of periodontal disease who have undergone treatment and have subsequently followed a careful oral hygiene. It should be noted that such bone is in a condition of lessened resistance, and as a consequence these septa are apt to break down suddenly; and in so doing may give rise to one type of the so-called "pyorrhœa abscess." Rarely this diffuse sclerosis may involve a whole alveolar process, generally that of the mandible, and in such a case the teeth appear as though implanted in a pale type of non-fibrillated compact bone.

(2) Infection viâ the Apical Foramen

When infection occurs from the diseased pulps of teeth the radiographic changes are similar to those described, but their starting point is about the apices of the teeth in question. Generally the periodontal membrane about the apex becomes thickened, and if the irritation be continued the membrane undergoes hypertrophic changes leading to a "granuloma." In other instances, when the infection is more acute and the surrounding tissue becomes purulent, the shadows about the root are hazy. Should a portion of the bone die its state can be diagnosed with certainty in the later stages only when the surrounding living bone becomes defined from the dead by a broadish line of rarefied tissue. Before this stage is reached the whole of the diseased tissue will give a diffused hazy shadow.

(C) CERTAIN CHANGES IN THE ROOTS OF THE TEETH

(1) Proliferative Periodontitis.—Radiographically thickening of the cement in the early stages is to be seen associated with a normal-looking periodontal membrane and an infected interdental septum—the infection of the bone having come either from the alveolar margin or from a neighbouring infected tooth. Thickening of a root suggests therefore infection of adjacent bone rather than of the periodontal membrane. The additional tissue is generally more translucent than normal cement, but by no means always so. The condition is therefore often missed. Care should be taken to distinguish an outgrowth on a root from the shadow of a second root.

(2) Rarefying Periodontitis.—Absorption may occur in a normal-looking root or in one affected with cementosis. In each case diagnosis rests upon irregularity in the outline of a surface in question, plus as a rule the breaking up of the lamina dura, and increase in breadth of the periodontal shadow.

(3) Translucency of Roots.—The diagnosis of translucency can be made with some certainty if the shadow of pathological cancellous tissue becomes apparent upon the shadow of the root. As a rule the addition of the shadow of normal cancellous tissue to that of a normal root is not seen, but should the root become more and more translucent to the rays, then the shadow of the cancellous tissue will become more and more prominent. It should be noted that translucency of the roots is practically always associated with a broken or absent lamina dura.

(D) SYSTEMATIC EXAMINATION OF DENTAL RADIOGRAMS

Let it be quite clear from the first that to hold up a dental radiogram at arm's-length against the daylight and expect to see fine detail is to expect the impossible. By so doing the clear rarefaction spaces of granulomata or of dental abscesses may be seen, but the far more common, though less obvious, changes will be missed. For their true appreciation it is necessary to examine them by strong transmitted artificial light and with the aid of a magnifying glass. Bearing these facts in mind, let us now turn to a systematic examination of a complete set of films.

View them as a whole. Note any change that is common to all, such, for example, as an increased or decreased brilliancy, an increased or decreased thickness of the trabeculæ, general loss of alveolar edges, the presence of an unusual number of granuloma rarefaction spaces, and so on. Then take a magnifying glass (say 1½ in. in diameter), and starting at the right upper molar region, examine each tooth successively.

Look for the condition at the cervical edge; examine the state of the periodontal membrane and of the lamina dura. Now leave the roots of the teeth and examine the bone around. Especially note the condition of the interdental and inter-radicular bone, and having done so, carefully scan all the remaining bony tissue to be seen on the film. Pass now to the next tooth. Systematically pursue the examination round the mouth, and at the end sum up mentally the general condition of the jaws and teeth. In forming a mental picture remember that you are dealing not so much with surfaces as with masses, that is, you have to estimate the amount of infection in three dimensions and not in two.

(E) THE CLINICAL IMPORTANCE OF BONE INFECTIONS

The assessing of the clinical importance of bone infections is, strictly speaking, not the duty of the radiologist. Nevertheless, in every case he will find it to his advantage definitely to make up his mind, even if he have no reason to express it. It is beyond argument, as is shown in this book, that these bone infections in the jaws do at times bear close and important relations to other diseases, and as it is clinically impossible to gauge the degree of jaw infection radiology becomes a necessity, though even with its aid it is possible at present to discover only lesions of some standing. It follows that the radiologist will become of more value the more certainly he can recognize the early stages of infection. The appearance of sclerosis in a film is evidence of a long-standing irritation, and long before its coming there must be a fine gradation of informing shadows which it is the duty of the radiologist to interpret. Thus a careful examination may show in a film that at first sight may appear normal, soft flares of rarefied bone passing, let us say, from the apex of a tooth in the direction of the lymphatic drain. What is the meaning of these flares? What is their importance to the patient?

An experienced radiologist might be excused for asking himself how far up to the present this new method of investigating dental disease has been of advantage to the patient.

PLATE I.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

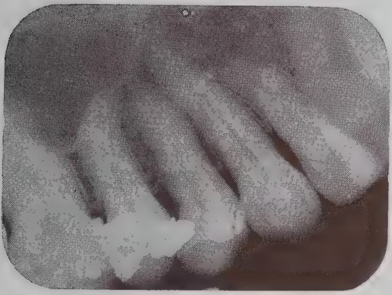

Fig. 952.

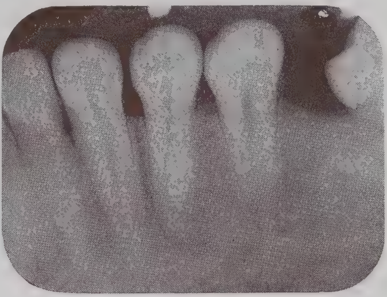

Fig. 953.

Fig. 952.—Practically normal maxillary teeth and bone. Note the fineness of the trabeculæ, the unbroken laminæ duræ, and the sharpness in outline of the periodontal shadow.

Fig. 953.—Practically normal tissue about the mandibular premolars. Note the general tendency of the trabeculæ downwards and forwards, the irregularity in shape of the cancellous spaces, and the absence of abnormal thickening of the trabeculæ.

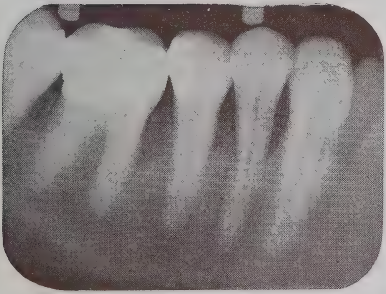

Fig. 954.

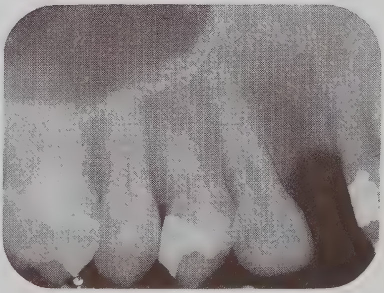

Fig. 955.

Fig. 954 shows (1) a well-marked destruction of the alveolar edge, with (2) but little obvious inflammatory change in the deeper bone. Note the comparatively unbroken state of the laminæ duræ.

Fig. 955 shows in particular cementosis of $\underline{5|}$, and the presence of "small round blackish spots surrounded by sclerosed bone" in the interdental septum between $\underline{6 \text{ and } 5|}$. The lower ends of the roots of $\underline{4 \text{ and } 3|}$ are probably translucent.

PLATE II.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

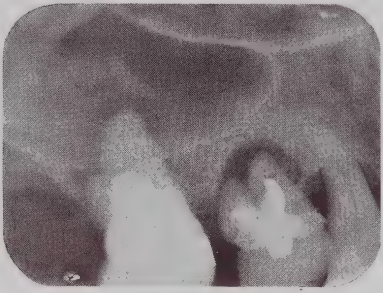

Fig. 956.

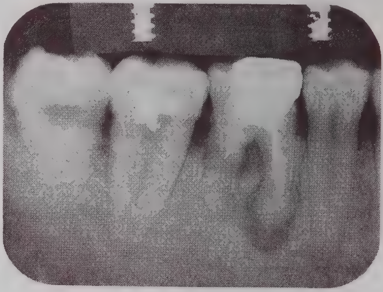

Fig. 957.

Fig. 956.—*Note:* (1) Rarefaction areas over the palatine and buccal roots of 7| ; the large areas of sclerosis on the floor of the maxillary sinus. (2) Marked absorption of roots of 6|, which roots are capped by large areas of rarefaction—a granuloma—beyond which the tissue is sclerosed. (3) Thickening of periodontal membrane of 5|.

Fig. 957.—*Note:* (1) Large area of rarefaction in relation to the anterior root of 6| (observe the small blackish round spots surrounded by sclerosed tissue in this shadow). (2) Posterior root of 6| is partially absorbed. (3) The bone behind the roots is much sclerosed. (4) Periodontal membrane of 7| has become infected and shows hazy thickening of its shadow.

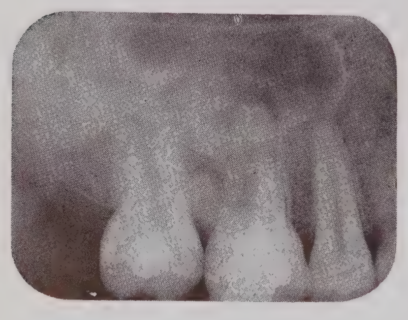

Fig. 958.

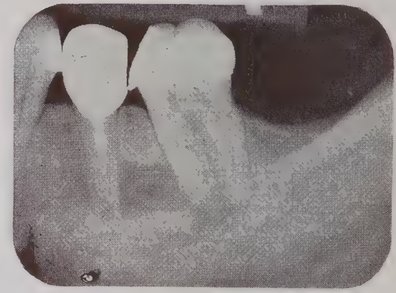

Fig. 959.

Fig. 958.—*Note:* (1) Rarefaction of the bone over apex of each root of 6|. (2) Sclerosis of bone on distal side of palatine root. (3) Comparative absence of infection of the septum between 6 and 5|. (4) The obvious hazy thickening of the periodontal membrane over the anterior buccal root of 7|.

Fig. 959 shows a large area of rarefied bone between the roots of |5 and 6. Below |5 is a woolly mass of sclerosis. The periodontal membrane of |6 is thickened and its roots translucent. (This is an example of a case in which clinical evidence of the condition was absent.)

PLATE III.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

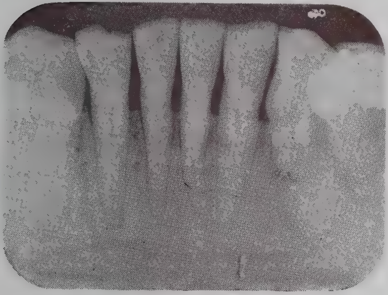

FIG. 960.

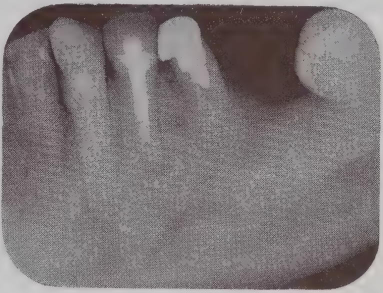

FIG. 961.

Fig. 960.—An example of a generalized diffuse sclerosis of the jaw. The teeth have the appearance of being embedded in non-laminated compact bone. From a patient much debilitated, and showing no obvious clinical evidence of disease in his mouth.

Fig. 961 shows (1) large areas of rarefaction in relation to the roots of $\overline{|3, 4, 5}$. Note how these areas tend towards the inferior dental canal into which those from $\overline{|3 \text{ and } 5}$ appear to open. (2) The well marked sclerosis of the remainder of the bone in the print. (3) Rarefaction areas between $\overline{|4 \text{ and } 5}$. (4) The unbroken edge of the alveolar process.

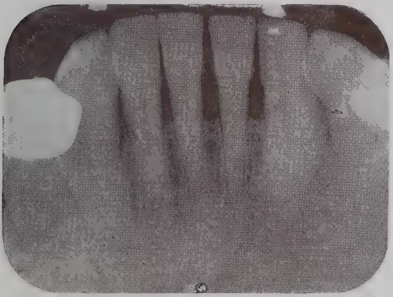

FIG. 962.

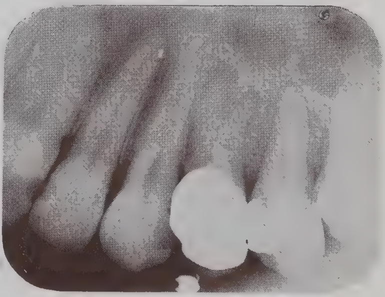

FIG. 963.

Fig. 962.—*Note :* (1) Loss of bone about the necks of the teeth. (2) The active carious changes at the edge of the bone shown by the irregular pittings on the edge. (3) The rarefaction of the interdental septa. (4) The slight thickening of the periodontal shadows. (5) The absence, thickening, or broken nature of the laminæ duræ.

Fig. 963 shows definite rarefaction of the bone about each apex of |4 ; the roots are translucent, the bone around infected. The infection from this tooth has infected the tissue about apex of |3 which shows thickening of periodontal membrane and of lamina dura. The infection may be traced to the tip of |2. The infection of the periodontal membrane of $\underline{|5}$ may or may not have come from $\underline{|4}$.

PLATE IV.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

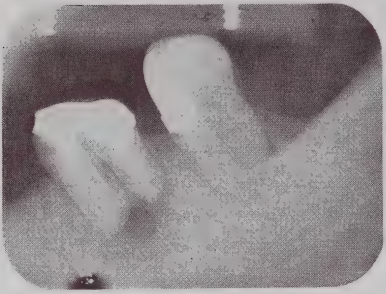

FIG. 964.

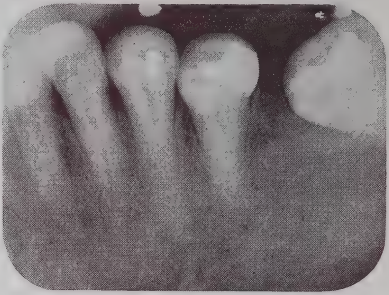

FIG. 965.

Fig. 964 shows a clear-cut round rarefaction space below and between the absorbed roots of |6, the condition suggesting a perforation of the inner or outer plate. Note, also, the marked sclerosis of the neighbouring bone, the thickening of the periodontal shadows of |7 and 8, and the faint rarefaction area beyond the apex of the anterior root of |7.

Fig. 965.—Note the largish rarefaction spaces about neck of |5. The alveolar edge is as yet unbroken; the bone below the rarefaction areas looks comparatively normal.

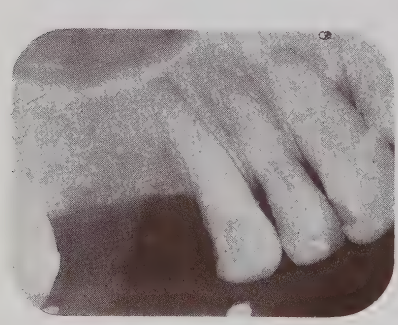

FIG. 966.

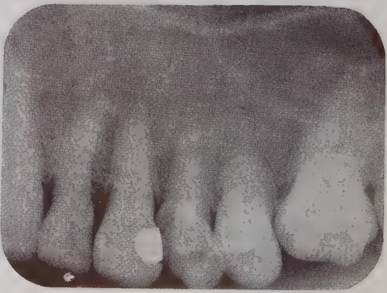

FIG. 967.

Fig. 966 shows (1) a largish area of irregularly porosed bone above 2|. (2) Thickening of the periodontal shadows about apices of 3 and 1|. (3) Marked alteration in the character of the edentulous bone—a residual infection.

Fig. 967.—(1) Note the altered character of all the cancellous tissue shown. (2) The faint but definite rarefaction of the bone over |2 and 3, the loss of lamina dura over the ends of each, and the thickened periodontal membrane at the end of |3. Changes in the bone can also be seen over the ends of |4 and 5. A low type of infection to which the tissues have shown very little reaction.

PLATE V.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

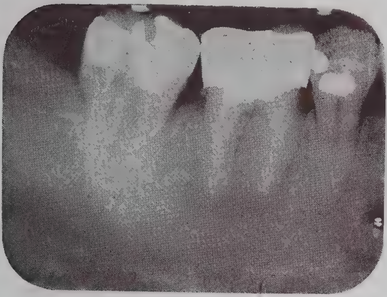

FIG. 968.

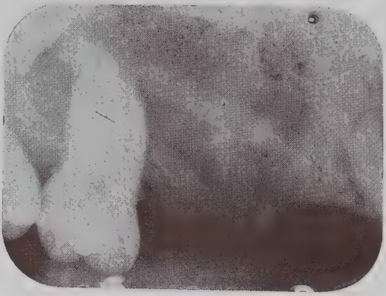

FIG. 969.

Fig. 968.—*Note :* (1) Rarefaction of the apex of the inter-radicular septum of $\overline{6}|$. (2) Alteration in character of this septum, showing rounding of the cancellous spaces with thickening of their walls. (3) Large faint rarefaction area beyond apices of $\overline{6}|$. (4) Sclerosis of bone distally. (5) Thickening of the periodontal shadow of $\overline{7}|$, evidently infected from $\overline{6}|$.

Fig. 969 shows a foreign body (match stick), embedded for about twelve years, in the bone below the maxillary sinus. The radiogram shows all the changes of rarefaction, sclerosis, &c., seen in relation to infection of the bone. It should be carefully studied.

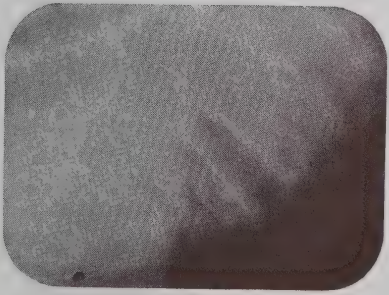

FIG. 970.

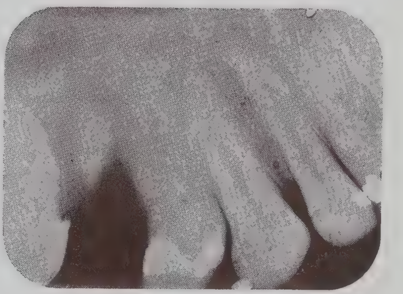

FIG. 971.

Fig. 970.—A film from the infected edentulous jaws of a man, aged 24, about five months after the extraction of his teeth. The patient had been exceedingly ill, and no cause could be found for his condition.

Note the general haziness of the details of the bone, the thickness of the trabeculæ and the mass of more sclerotic-looking tissue in the position of $\underline{4}|$. A small piece of bone was trephined with aseptic care from the region of $\underline{4}|$ through the outer alveolar plate, and from it a pure growth of *Staphylococcus aureus* was obtained. Such a film as this appears when examined on a suitable view box as a "dull" or "bad" radiogram. The rest of the films of this patient's jaws gave a similar appearance.

Fig. 971.—A film from the jaw of a doctor, a male, aged about 30, who had just suffered from a severe and prolonged attack of fibrositis. Careful examination of cultures from the ends of the roots gave a pure growth of a "rough-growing" streptococcus.

Note the marked general sclerosing due to a thickening of the trabeculæ and a rounding of the cancellous spaces. Such a film as this appears when examined on a suitable view box as a "bright" or "good" radiogram. It may be noted that the radiograms of the whole mouth gave similar appearances.

PLATE VI.—RADIOGRAMS.

Examine these prints in a moderately strong reflected light.

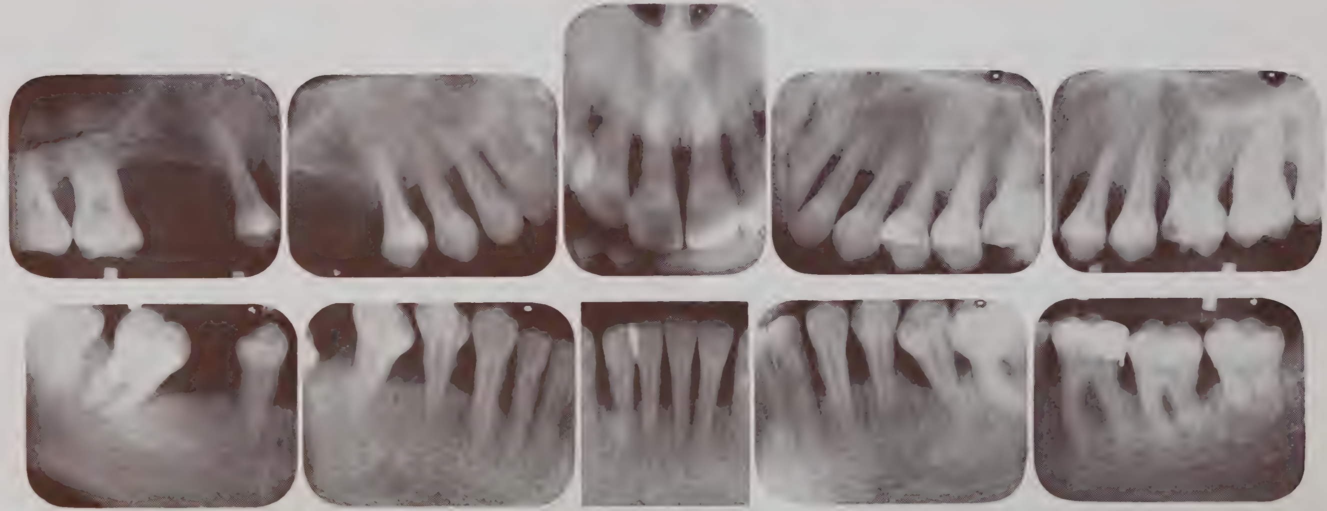

Fig. 972.—Radiogram of a case of severe general periodontitis. Female, aged 24, suffering from debility, indigestion, and severe anæmia.

Note: (1) The general marginal osteitis which has caused a marked destruction of the alveolar edges. (2) The hazy thickening in outline of most of the periodontal shadows. (3) The thickened or broken state, or even absence of the laminæ duræ. (4) The obvious changes in pattern of the cancellous tissue of the maxilla, of a type suggesting a chronic inflammation of the bony tissue—a chronic osteomyelitis. (5) The comparative lack of gross changes in the same tissue of the mandible. Observe certain streaks of rarefaction passing through the centre of some of the interdental septa and entering the bone below. (6) Mass of sclerosed bone above $\underline{|4}$. (7). The presence of cementosis in $\begin{array}{r|l} 4 & \\ 543 & 345. \end{array}$

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